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ENGINEERING TEST OF UH-1B HELICOPTER EQUIPPED WITH FLOATATION LANDING GEAR

FINAL REPORT

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U. S. ARMY AVIATION TEST ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA

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ABSTRACT

A limited engineering flight test evaluation of a UH-1B equipped with floatation landing gear was conducted by the U. S. Army Aviation Test Activity (USAAVNTA). The objectives of the program were to verify and amplify the data obtained during the manufacturer's flight testing and establish the basis for the Operator's Manual data to be used for UH-1B helicopters equipped with floatation landing gear.

The USAAVNTA was designated Executive Test Agency and was responsible for test plan preparation, test execution, and test reporting. A total of 40 flights for 27 productive flight hours was flown at Edwards Air Force Base and Bakersfield, California, from 27 July 1965 through 10 September 1965.

The UH-1B equipped with floatation landing gear could be flown with reasonable safety within a restricted flight envelope compared with a standard UH-1B. The overall flying qualities were inferior to those of a standard UH-1B. Installation of the floatation landing gear resulted in a significant performance penalty. The water handling characteristics were considered excellent.

Several warning statements and notations describing peculiarities in handling qualities were recommended for insertion in the Operator's Manual for operating UH-1B's with floatation landing gear. A restricted flight envelope was recommended for the UH-1B equipped with floatation landing gear. The performance test results were recommended for incorporation in the Operator's Manual.

FOREWORD

1. Authority

Letter, AMSTE-BG, Headquarters, U. S. Army Test and Evaluation Command, 11 December 1964, subject: "Test Directive, USATECOM Project No. 4-5-5301-01, Engineering Test of UH-1B Helicopter Equipped with Bell Helicopter Floatation Gear."

2. References

A list of references is contained in Appendix V.

PHOTO 1 - UH-1B

PHOTO 2 - UH-1B

SECTION 1. GENERAL

1.1 TEST OBJECTIVES

a. To verify and amplify the data obtained during the manufacturer's flight testing.

b. To establish the basis for the Operator's Manual data to be used for UH-1B helicopters equipped with floatation landing gear.

1.2 RESPONSIBILITIES

The U. S. Army Aviation Test Activity (USAAVNTA)was designated Executive Test Agency and was responsible for test plan preparation, test execution, and test reporting.

1.3 DESCRIPTION OF MATERIEL

The floatation landing gear tested consisted of two rubberized fabric floats 33 inches in diameter and 20 feet long. The floats were attached to the helicopter by cross tubes and full-length aluminum tubes integral to each float which replaced the conventional skids and cross tubes. Each float was inflatable with a normal charge of 1.5 pounds per square inch in each of the five separate compartments comprising it. A horizontal fixed stabilizer with a 36-inch span and an 18-inch chord was installed on the standard tail skid.

The aircraft upon which the floats were installed was a standard UH-1B, S/N 60-3548, equipped with a T53-L-9A engine.

1.4 BACKGROUND

Two agencies, the Army Air Defense Command (ARADCOM) and the Special Warfare Center, were interested in obtaining a limited number of floatation landing gears for their UH-1 helicopters.

ARADCOM was interested in the necessity and desirability of having the floatation landing gears for emergency use on six of their aircraft operating in the New York, Miami, Seattle and San Francisco areas.

Special Warfare Center was interested in exploring the feasibility of using floatation-landing-gear-equipped helicopters in remote areas for special warfare operations. This type of use encompasses operation in water of a variety of sea states and flow velocities.

The contractor performed limited testing of the floatation landing gear and recorded the resulting airspeed, center-of-gravity (C.G.), altitude and gross weight envelope in reference a, Section 3, Appendix V. The data obtained was insufficient, however, to establish the effect of the floatation gear upon the performance and stability and control of the UH-1B helicopter.

The U. S. Army Materiel Command (USAMC) assigned a joint engineering/service test of the UH-1B helicopter equipped with floatation landing gear to the U. S. Army Test and Evaluation Command (USATECOM) on 20 June 1964. In Test Directive, 11 December 1964, USATECOM assigned the engineering test to USAAVNTA. Test plan submitted by USAAVNTA was approved by USATECOM on 19 February 1965.

Testing consisted of 40 flights for a total of 27 productive flight hours and was conducted at Edwards Air Force Base and Bakersfield, California, from 27 July through 10 September 1965.

1.5 CONCLUSIONS

a. The UH-1B equipped with floatation landing gear could be operated with reasonable safety within the reduced flight envelope prescribed in paragraph 1.6, Recommendations.

b. The overall flying qualities of the UH-1B equipped with floatation landing gear were inferior to those of a standard UH-1B.

c. A significant performance penalty was experienced by a UH-1B equipped with floatation landing gear compared with a standard UH-1B.

d. The water handling characteristics of the floatation-landing-gear-equipped UH-1B were excellent.

1.6 RECOMMENDATIONS

a. Operations with the UH-1B equipped with floatation landing gear should be limited to the following flight envelope:

(1) Maximum gross weight - 8000 pounds (reference paragraph 2.0).

(2) Center-of-gravity limits - Forward limit Station 126
Aft limit Station 134
(reference paragraph 2.0).

(3) Maximum altitude - 10,000 feet (reference a).

(4) Maximum airspeed (V_{NE}) - 95 knots calibrated airspeed (KCAS) (reference paragraphs 2.2.1.4, 2.2.2.4, 2.2.4.4, 2.2.5.4) or placard airspeed in Operator's Manual (TM 55-1520-211-10), whichever is less.

(5) Maximum winds for crosswind and downwind hovering operations - 25 knots (reference paragraph 2.2.6.4).

b. The performance results obtained during this evaluation should be incorporated in the Operator's Manual (reference f) (paragraph 2.1).

c. The following appropriate warning statements should be incorporated in the Operator's Manual for operation of UH-1B's equipped with floatation landing gear:

(1) Explain the hazards involved in making a run-on autorotative landing on land in a nose-high attitude (reference paragraph 2.1.4.2).

(2) Explain the hazards involved in making a less than 10-knot touchdown speed autorotative landing on water (reference paragraph 2.1.4.2).

d. The following appropriate notations should be included in the Operator's Manual for operating the UH-1B equipped with floatation landing gear:

(1) Describe the optimum techniques to make autorotative landings on both land and water (reference paragraph 2.1.4.2).

(2) Describe the techniques for handling the aircraft on water (reference paragraph 2.2.7.4).

(3) Describe the undesirable handling qualities occurring at high airspeeds in level flight (reference paragraphs 2.2.1.4, 2.2.2.4, 2.2.4.4 and 2.2.5.4).

(4) Describe the deterioration of handling qualities compared with those of a standard UH-1B existing when hovering in winds (reference paragraph 2.2.6.4).

SECTION 2. DETAILS OF TEST

2.0 INTRODUCTION

The tests described in this section were conducted during non-turbulent atmospheric conditions to eliminate the unpredictable influence of turbulence upon the test data. All data was gathered using calibrated airborne test instrumentation.

Stability and control test results were conducted in accordance with and compared with the requirements of MIL-H-8501A (reference g).

Testing consisted of 40 flights for 27 productive flight hours and was conducted at Edwards Air Force Base and Bakersfield, California, from 27 July 1965 through 10 September 1965.

The helicopter on which the floats were installed was a standard UH-1B, S/N 60-3548. No change in elevator or swashplate rigging from that specified for a standard UH-1B was used for the float configuration tests although a fixed stabilizer was installed on the tail skid as part of the floatation landing gear.

Many of the tests scheduled in the test plan (reference c) were not accomplished because of premature deployment of the test aircraft. Tests were conducted in an order designed to provide the maximum information in the minimum time and still be consistent with safety of flight. Gross weights varying from 6500 pounds to 8000 pounds with center of gravity (C.G.) varying from Station 126 (forward) to Station 134 (aft) were evaluated during these tests. Until further testing is accomplished operation of UH-1B's equipped with floatation landing gear should be confined to this loading envelope.

2.1 PERFORMANCE

2.1.1 Hover

2.1.1.1 Objective

The objective of these tests was to determine if the installation of the floatation landing gear resulted in a decrease in hovering performance compared with that of a standard UH-1B.

2.1.1.2 Method

The free-flight hovering technique was used for the hovering tests. The helicopter was stabilized at floatation landing gear

heights of 5 feet and 15 feet above the ground at an average density altitude of 3000 feet. Gross weights varied from 6800 pounds to 8800 pounds and rotor RPM varied from 293 to 331 rpm. The parameters necessary to establish power required and test ambient conditions were recorded while the aircraft was in a stabilized hover. All hovering tests were conducted in winds of less than 3 knots.

2.1.1.3 Test Results

The results of the hovering tests are presented graphically in Figure 1, Appendix I.

2.1.1.4 Analysis

The limited in-ground-effect (IGE) hovering tests conducted indicated that the hovering performance of a UH-1B equipped with floatation landing gear and a standard UH-1B were essentially equivalent. A comparison of the non-dimensional hovering performance (Figure 1, Appendix I) with the similar presentation in the YHU-1B Category II Performance Tests (reference h) indicated that the data is within the scatter band of that of the standard UH-1B at the same skid or float height. These results were unexpected since the rotor gimbal, hence rotor, of the UH-1B with floatation landing gear was approximately 20 inches higher above the ground than that of the UH-1B with the standard skid gear. Similar results were obtained by the airframe contractor during certification of the floatation landing gear on the commercial model 204B helicopter, as reported in reference a.

2.1.2 Climb

2.1.2.1 Objective

The objective of these tests was to determine the loss in climb performance due to the installation of the floatation landing gear on the UH-1B.

2.1.2.2 Method

Two check climbs were flown in the UH-1B equipped with the floatation landing gear to the 10,000-foot altitude placard limit at each of two gross weights. Tests were conducted at engine start gross weights of 6600 pounds and 7660 pounds at a mid C.G. loading.

2.1.2.3 Results

Test results are presented graphically in Figures 2 and 3, Appendix I.

2.1.2.4 Analysis

The sea-level standard-day rate of climb at an engine start gross weight of 7660 pounds was 1550 feet per minute (fpm) as compared with 1950 fpm for a standard UH-1B flown at the same conditions. This represented a 20-percent decrease in climb performance due to the relatively high-drag floatation landing gear. The test climbs were flown at airspeeds approximately 5 to 10 knots higher than the airspeeds for minimum power as derived from the level flight performance tests. However, due to the flatness of the "bucket" of the speed-power polar for the floatation landing gear-equipped UH-1B, the effect on climb performance due to the airspeed difference in climb schedule should be minor.

No deterioration in flying qualities during stabilized climbs was apparent to the pilot as compared with a standard UH-1B. No problems were experienced in maintaining a predetermined climb schedule.

2.1.3 Level Flight

2.1.3.1 Objective

The objective of these tests was to define the power required as a function of airspeed. This in turn was used to determine range and maximum airspeed performance penalties due to the installation of the floatation landing gear.

2.1.3.2 Method

Five level flight performance tests were conducted at gross weights varying between 6520 pounds and 8510 pounds and density altitudes ranging from 1940 feet to 9050 feet. Level flight tests were flown at a constant thrust coefficient (C_T); this involved increasing altitude on successive data points as fuel was used. All data was taken in stabilized level flight. A non-dimensional presentation was used to define the performance for any combination of gross weight or altitude.

2.1.3.3 Results

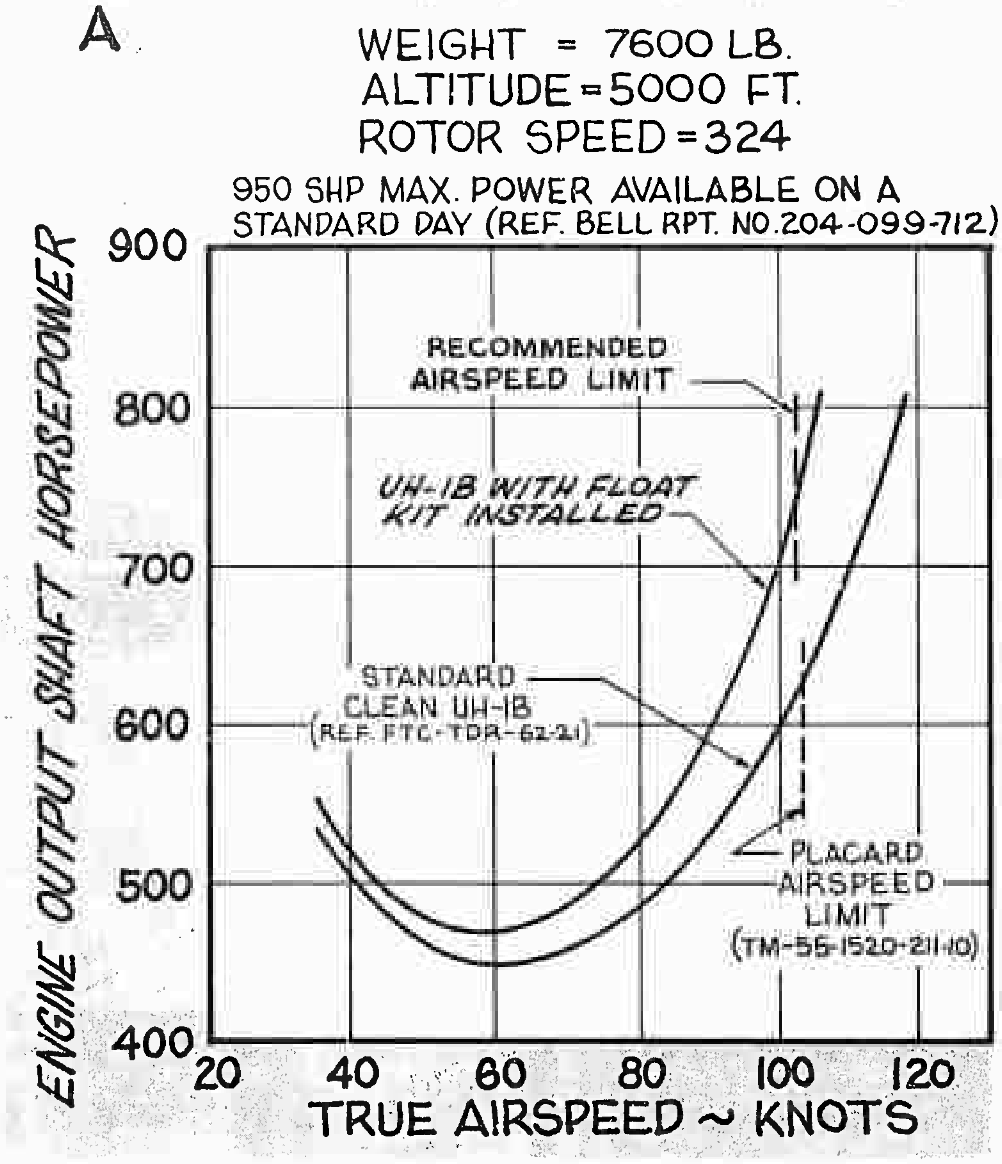
The results of all the level flight tests are presented in non-dimensional form in Figures 4 through 6, Appendix I. Individual level flight performance test results are presented graphically in Figures 7 through 11.

2.1.3.4 Analysis

The performance penalty in terms of power required due to

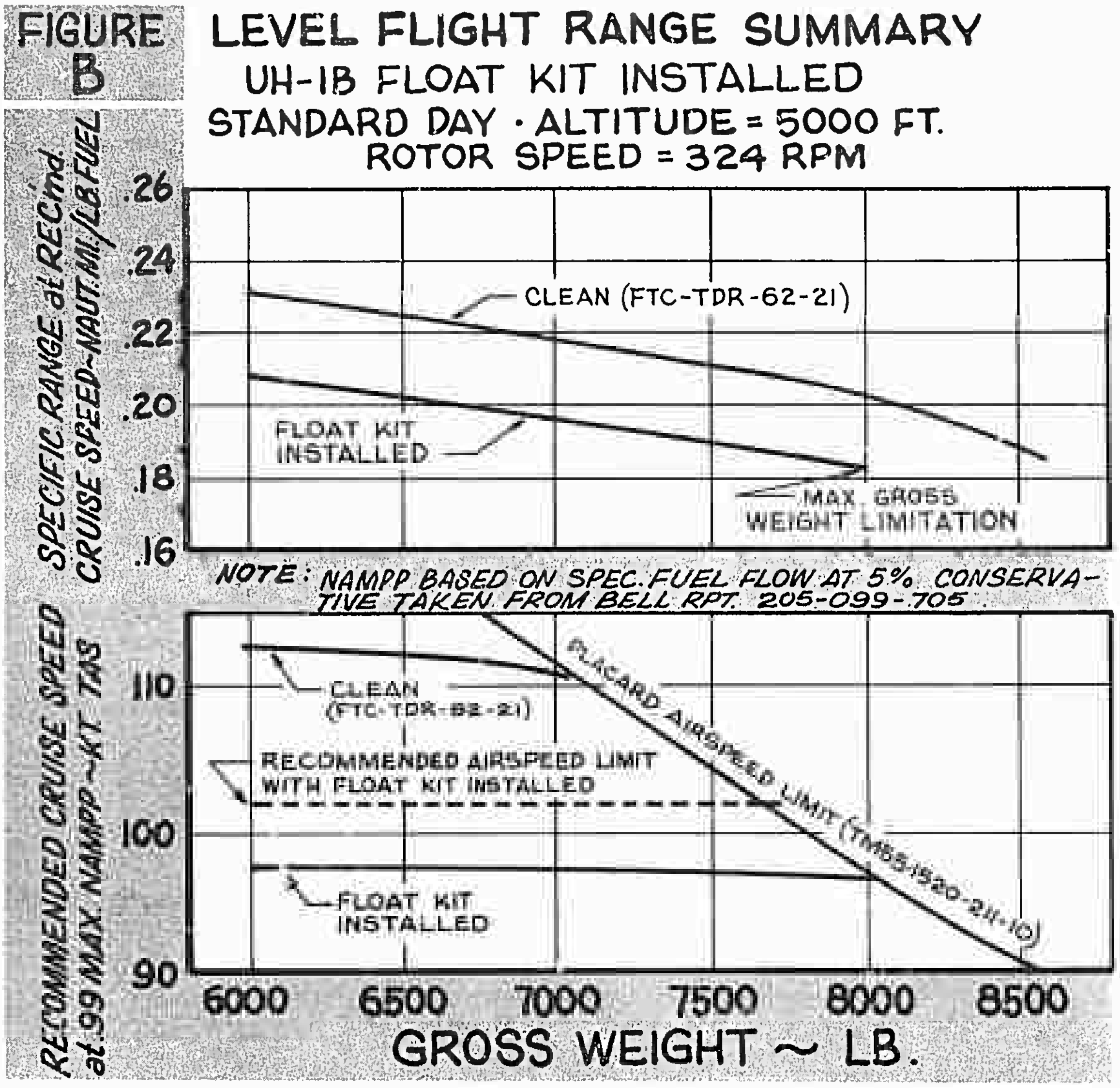
the installation of the floatation landing gear is shown in Figure A.

FIGURE A PERFORMANCE COMPARISON



The float-equipped UH-1B required 114 SHP (18.4 percent) more than the standard clean UH-1B for the conditions shown in Figure A at the float-equipped UH-1B recommended placard airspeed limit of 102 KTAS (95 KCAS). This is equivalent to an increased fuel flow of 66 pounds/hour. At the power level required to cruise the standard clean UH-1B at 102 KTAS for the conditions shown, the installation of the floats has the effect of reducing the airspeed 10 KTAS. At the airspeed for minimum power required the float-equipped UH-1B required 22 SHP (4.9 percent) more than the standard clean UH-1B.

The performance penalty in terms of specific range performance is shown in Figure B.



The installation of the floats resulted in a 9.4-to 10.7-percent decrease in specific range of the float-equipped UH-1B, dependent upon gross weight. At 8010 pounds, the recommended cruise speed for the float-equipped UH-1B and the placard airspeed limit of the standard clean UH-1B are equal (97 KTAS). As the gross weight is reduced the recommended cruise speed of the standard clean UH-1B becomes higher than that of the float-equipped UH-1B. At 6600 pounds, the recommended cruise speed of the standard clean UH-1B is 112 KTAS and that of the float-equipped UH-1B is 97.5 KTAS.

2.1.4 Autorotation

2.1.4.1 Objective

The objectives of these tests were to determine the effects of the floatation landing gear installation on the UH-1B as indicated:

a. Define the airspeed for minimum rate of descent in stabilized autorotation.

b. Determine the height-above-ground-versus-airspeed relationship (Deadman's Curve) that will result in a safe autorotational landing following an engine failure over water.

c. Establish the optimum pilot techniques for performing autorotational landings on water or land.

2.1.4.2 Method

Autorotational sawtooths were conducted to determine the airspeed for minimum rate of descent and the minimum rate of descent during stabilized autorotations. The autorotational sawtooths consisted of establishing stabilized autorotations at various airspeeds, then for each airspeed recording the time to pass through a selected increment of altitude.

The "Deadman's Curve" was developed by simulating an engine failure by rapidly reducing power with the collective twist grip (gas producer speed control), delaying 1 to 2 seconds before lowering the collective control, establishing a stabilized autorotation, and executing an autorotative touchdown on water. Autorotative landings were conducted at a given engine failure airspeed at successively lower altitudes until a minimum altitude consistent with safety was reached. Repetitions of the above autorotative landing technique were conducted at different airspeeds to define a curve of safe altitude versus airspeed. Simulated engine failures were conducted in both climbs and level flight. Tests were conducted at an average gross weight of 8000 pounds and an average density altitude of 3000 feet. Autorotative touchdowns on water were conducted at touchdown airspeeds as low as zero knots and as high as 45 knots.

Autorotative techniques during water landings were straightforward and easy to accomplish. There were, however, important variations in procedures in operations applicable to water as opposed to land. Initial pilot response to engine failure or entry into autorotation was unchanged from that in basic UH-1B operations. The following procedures should be used by pilots during operations with floatation-landing-gear-equipped UH-1B's. After establishing autorotative flight at 60 knots indicated airspeed (KIAS) in accordance

with the procedures determined by the type of failure, a decision should be made as soon as possible as to whether the landing is to be made on land or water. If a choice is available, a water landing is preferred when water conditions are satisfactory and wave height is less than 2 feet. For wave heights of less than 2 feet, the landing should be made into the wind and, therefore, into the waves. For wave heights of more than 2 feet, autorotation should be planned to land 90 degrees to wave motion or crosswind, with a right crosswind preferred and touchdown on a wave crest. A moderate flare should be executed at 20 to 25 feet to reduce forward speed and arrest rate of descent. At this time, procedures will vary depending on whether the aircraft is to be landed on water or land.

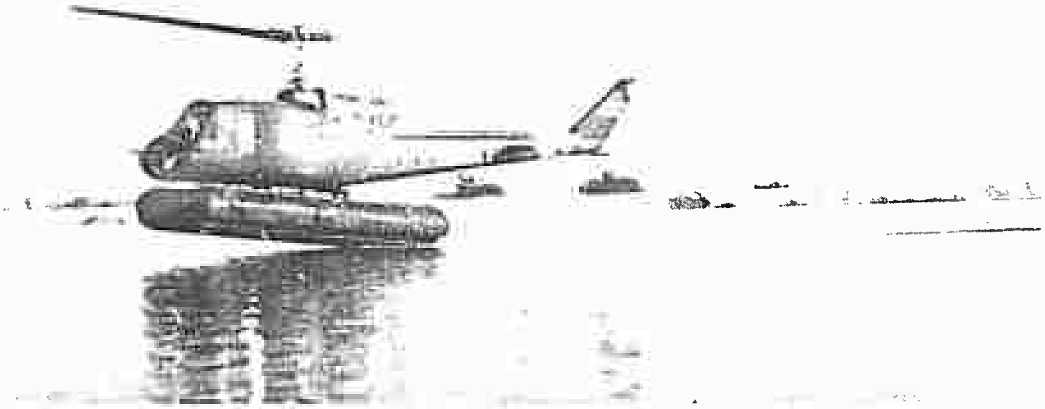


PHOTO 3 - Autorotational Touchdown on Water

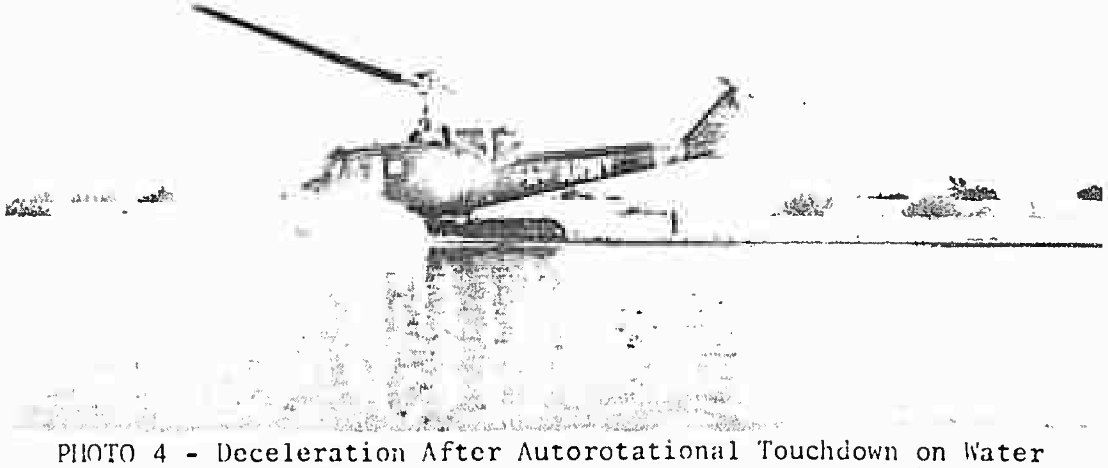


PHOTO 4 - Deceleration After Autorotational Touchdown on Water

a. Water

Autorotative landing on water with floats is accomplished in a fuselage level attitude only when landing from hover or with less than 5 knots of ground speed. Landing from normal autorotative glide is achieved by using the flare to reduce airspeed, arrest rate of descent and control a smooth "run on"-type touchdown in a nose-high attitude. Touchdown should be in an approximately 5-degree nose-high attitude at 12 to 18 knots ground speed. Minimum collective pitch should be used prior to touchdown unless flare has not been sufficient to arrest rate of descent. Touchdown with a 5-degree nose-high attitude will be on the back of the floats and a slightly nose-up attitude should be maintained to prevent the forward end of the floats from "digging in." Aft cyclic and collective pitch are used to prevent the floats from digging in while water drag on the floats decelerates the helicopter. The following warning statements should be inserted in the Operator's Manual for UH-1B's equipped with the floatation landing gear:

Autorotative landing on water will result in "digging in" and possibly tipping over forward in a fuselage-level attitude with over 5 knots of forward ground speed.

Attempts to reduce water touchdown speeds below 10 knots following an autorotative glide may result in excessive use of collective pitch prior to touchdown and insufficient control will remain to prevent the floats from "digging in."

b. Land

Autorotative operations on land are unchanged from standard configuration operations with skids except that ground speeds should be reduced to zero if possible. The aircraft should be landed in a fuselage level attitude.

The following warning statement should be included in the Operator's Manual (reference f) for UH-1B operation with floatation landing gear installed:

Autorotative touchdowns on land in other than a fuselage level attitude will result in porpoising of the aircraft due to the bouncing tendency of the floatation landing gear.

2.1.4.3 Test Results

The results of the autorotational sawtooth tests are presented graphically in Figure 14, Appendix I. The "Deadman's Curve" is presented graphically in Figure 15.

2.1.4.4 Analysis

The minimum rate of descent was 1740 fpm as compared with 1630 fpm for a standard UH-1B. This comparison was made at a gross weight of approximately 6600 pounds and a density altitude of 5000 feet. The calibrated airspeed for minimum rate of descent was 50 knots as compared with 55 knots for the standard UH-1B.

The "avoid" area of the "Deadman's Curve" appeared to be only slightly greater than that for a standard UH-1B. An accurate comparison was not possible because the gross weight and density altitude of the "Deadman's Curve" presented in the standard UH-1B evaluation (reference h) were slightly different from those present during these tests. Below 50 KIAS, the test aircraft required an additional 50 to 100 feet to execute safely an autorotative landing on water compared with standard UH-1B operations on land.

2.1.5 Airspeed Calibration

2.1.5.1 Objective

The objective of these tests was to determine the position error for both the ship standard and test boom airspeed systems for the UH-1B equipped with floatation landing gear.

2.1.5.2 Method

The airspeed systems were calibrated in level flight by using a calibrated trailing bomb. The trailing bomb had a zero position error and, compared with the instrument-corrected ship and boom systems airspeed indicator readings, yielded position error directly.

2.1.5.3 Test Results

The results of the airspeed calibration test are presented graphically in Figure 16, Appendix I.

2.1.5.4 Analysis

The position error of the ship standard airspeed system was acceptable up to the recommended placard limit airspeed of 95 KCAS. The largest error was a positive 5 knots occurring at 80 KIAS. At 95 KIAS the position error was a positive 2 knots and was acceptable. The trend of the position error at airspeeds higher than 95 KIAS was toward the favorable negative position error direction. This characteristic is common to standard UH-1B's.

The position errors of the ship airspeed system determined during this evaluation agreed reasonably well with those of a standard UH-1B. Therefore, it is recommended that the position error published in the Operator's Manual for the standard UH-1B be used for UH-1B's equipped with floatation landing gear.

2.2 STABILITY AND CONTROL

2.2.1 Static Longitudinal Stability

2.2.1.1 Objective

The objective of these tests was to record and evaluate the longitudinal control motions required to vary airspeed. The airspeed-control position gradients were evaluated with respect to the degree of stability, control margins, and presence of any objectionable control position discontinuities.

2.2.1.2 Method

The static longitudinal stability was evaluated using two methods. The first method consisted of trimming the helicopter at each of the several trim conditions listed in MIL-H-8501A (reference g), then using the controls as required to vary the airspeed about this trim point. The collective control was held fixed at the trim position, allowing altitude to vary as airspeed was changed during this maneuver. Data was recorded when the helicopter was completely stabilized. Tests were conducted in climb, level flight and autorotation at an average density altitude of 5000 feet, an average gross weight of 6600 pounds, and an aft C.G.

The second method consisted of recording and evaluating the control position required to maintain stabilized level flight. Data obtained was recorded during the conduct of the level flight tests.

2.2.1.3 Test Results

The results of the static longitudinal stability tests are presented graphically in Figures 17 through 21, Appendix I.

2.2.1.4 Analysis

The UH-1B equipped with floatation landing gear exhibited positive static longitudinal stability at all conditions tested at airspeeds faster than 40 KCAS. The normal static longitudinal instability occurring below 40 KCAS in the standard UH-1B was also present in the UH-1B equipped with floatation landing gear. The degree of instability in this case was higher than that of a

standard UH-1B but this was not considered objectionable by the pilot.

No objectionable control displacement discontinuities or insufficient control margins were encountered during any of the conditions tested.

The aircraft nose-down pitch attitude became uncomfortably large at airspeeds above 90 KCAS. This was one of the factors which resulted in the recommended placard airspeed of 95 KCAS.

2.2.2 Static Lateral-Directional Stability

2.2.2.1 Objective

The objective of these tests was to insure that the UH-1B equipped with floatation landing gear possessed positive directional stability and effective dihedral and did not exhibit excessive longitudinal trim changes during steady-state sideslips.

2.2.2.2 Method

The static lateral-directional stability tests were conducted at an average gross weight of 6700 pounds and a forward C.G. at an average density altitude of 5000 feet. Tests were conducted in level flight at airspeeds of 35, 75 and 95 KCAS. The aircraft was stabilized in level flight at the specified airspeed and altitude. Stabilized non-turning sideslips to both the left and right were executed in approximately 3-degree increments. The collective control was held fixed at the trim position with other controls varied as required to obtain the desired sideslip angle. Throughout the sideslip, airspeed was maintained at the trim indicated value with altitude allowed to vary.

2.2.2.3 Test Results

Results of the static lateral-directional stability tests are presented graphically in Figures 22 through 24, Appendix I.

2.2.2.4 Analysis

The test aircraft exhibited positive directional stability, as indicated by the variance of pedal position versus sideslip angle, throughout the level flight airspeed range tested. The degree of directional stability increased as airspeed increased.

The effective dihedral during steady-state sideslips was neutral at low airspeeds and became highly negative at high air-

speeds. This characteristic was considered a major shortcoming of the UH-1B equipped with floatating landing gear and was a violation of paragraph 3.3.9 of MIL-H-8501A (reference g). This characteristic was aggravated at high airspeeds in a left sideslip by a large (i.e., 2-inch) nose-down longitudinal trim change. There was very little longitudinal trim change in a right sideslip. The combination of these factors at high airspeeds gave the pilot the impression of impending divergence about the roll axis at 8- to 10-degree sideslip angles and is one of the factors prompting a recommended airspeed limitation of 95 KCAS when operating the UH-1B with floatation landing gear.

2.2.3 Dynamic Stability

2.2.3.1 Objective

The objectives of these tests were to record and evaluate the response of the UH-1B equipped with floatation landing gear to control pulse-type disturbances.

2.2.3.2 Method

Tests were conducted in level flight at an average gross weight of 6600 pounds and an average density altitude of 5000 feet. Both a forward C.G. (Station 126) and an aft C.G. (Station 134) were investigated at calibrated airspeeds of 75 knots and 95 knots. Tests were conducted in a hover at an aft C.G., an average gross weight of 6600 pounds and a density altitude of 3000 feet. At each test condition a disturbance was introduced about each axis in both directions. The disturbance was generated with a 1-inch control input which was held for 1 second, then returned to the original trim position. The ensuing aircraft motion was allowed to persist until it damped out or recovery became necessary. A control fixture was used to insure precise inputs.

2.2.3.3 Test Results

Results of the dynamic stability tests conducted at a forward C.G. and 95 KCAS are presented in the form of time histories, in Figures 25 through 30, Appendix I.

2.2.3.4 Analysis

No objectionable flight characteristics were found during any of the dynamic stability tests conducted.

The response of the UH-1B equipped with floatation landing gear to either lateral or longitudinal disturbances was well damped

and appeared to be similar to that of a standard UH-1B.

Following a directional disturbance at high airspeeds a complex pitch-roll-yaw coupled motion resulted. This was particularly true following a right pedal input. This was explained by the negative dihedral and longitudinal trim change which occurred in left sideslips and were described in paragraph 2.2.2.4. Following a right pedal input the helicopter entered a left sideslip and the corresponding moments generated by the negative dihedral and longitudinal trim changes introduced lateral and longitudinal coupling to the basic directional motion. This motion, however, had a long enough period so that it was not objectionable.

2.2.4 Controllability

2.2.4.1 Objective

The objective of these tests was to insure that the floatation landing gear installed on the UH-1B did not cause any objectionable control problems.

2.2.4.2 Method

Controllability tests were conducted at the same conditions as the dynamic stability tests (paragraph 2.2.3.2). Various-size step control inputs were introduced about each axis in both directions. The inputs were held until the maximum rates had been achieved or until recovery became necessary. A control fixture was used to insure precise inputs.

2.2.4.3 Results

Results of the controllability tests conducted at an aft C.G. and 95 KCAS are presented graphically in Figures 31 through 35, Appendix 1.

2.2.4.4 Analysis

The controllability of the UH-1B equipped with floatation landing gear, when expressed in terms of maximum rates and angular accelerations achievable per inch of control deflection and times to reach these maximums, was essentially the same as that of a standard UH-1B about both the roll and yaw axes. A small though noticeable decrease in controllability resulted about the pitch axis. The pitch rate, except for its lower maximum value, exhibited essentially the same damping characteristics as those of a standard UH-1B.

Roll and yaw axis coupling following either lateral or directional step control inputs, however, resulted in undesirable

flying qualities. This coupling was considered a major shortcoming of the UH-1B equipped with floatation landing gear. The problem stemmed mainly from the negative dihedral occurring in left sideslips that was described in paragraph 2.2.2.4. The control coupling, therefore, was most pronounced following control inputs which resulted in left sideslip. A right lateral input was accompanied by complementary yaw, (i.e., left sideslip), and a right pedal input immediately resulted in left sideslip. Figure 33, Appendix I shows a typical right lateral step at high speed. The aircraft gear initially followed the control input in a manner similar to that of a standard UH-1B. At a bank angle between 25 and 30 degrees the roll rate suddenly began to increase in value, probably due to the combination of complementary yaw (i.e., left sideslip) and its resulting negative dihedral. This sudden increase in roll rate was alarming to the pilot. A similar situation resulted following a right directional step and is shown in Figure 35. These characteristics increased in severity with airspeed and are among the reasons for the recommended placard airspeed of 95 KCAS. An appropriate notation should be included in the Operator's Manual to advise the operators of UH-1B's equipped with floatation landing gear of the controllability characteristics which result from uncoordinated rolling and yawing maneuvers.

2.2.5 Simulated Engine Failures

2.2.5.1 Objective

The objective of these tests was to determine if handling qualities were satisfactory following an engine failure on a UH-1B equipped with floatation landing gear.

2.2.5.2 Method

Power failures were simulated by rapidly reducing power with the collective twist grip (gas producer speed control). The collective pitch control was not lowered for at least 2 seconds following the failure. Tests were conducted in level flight at airspeeds as high as 95 KCAS and in a hover. Tests were conducted at both a forward and an aft C.G. at gross weights varying from 6500 pounds to 8000 pounds.

2.2.5.3 Test Results

The results of the simulated engine failure tests were based on the qualitative opinions of an experienced engineering test pilot and are discussed in paragraph 2.2.5.4, Analysis.

2.2.5.4 Analysis

The response of the UH-1B equipped with floatation landing gear to simulated engine failures in a hover and at low airspeeds was essentially the same as that of a standard UH-1B. At higher airspeeds the higher power required and increased nose-down pitch attitude attributable to the installation of the floatation landing gear resulted in a larger nose-up trim change and yaw left following engine failure than occurred with a standard UH-1B. The rotor speed also tended to decay faster and, on one occasion following a simulated failure at 95 KCAS at an aft C.G. loading, blade stall was encountered in 2.5 seconds, after the rotor speed had bled to 255 rpm. These factors coupled with the shortcomings previously discussed contributed to the decision to limit airspeeds of the UH-1B with the floatation landing gear installed to 95 KCAS.

2.2.6 Sideward and Rearward Flight

2.2.6.1 Objective

The objective of these tests was to determine if sufficient control was available to hover the UH-1B equipped with floatation landing gear in crosswinds and tailwinds of 30 knots.

2.2.6.2 Method

Hovering in crosswinds was simulated by flying in stabilized sideward flight. Hovering in tailwinds was simulated by flying in stabilized rearward flight. A calibrated pacer vehicle was used to provide a stable reference and an accurate indication of the true airspeed. Tests were conducted at both a forward and an aft C.G.

2.2.6.3 Test Results

The results of the sideward and rearward flight tests are presented graphically in Figures 36 through 39, Appendix I.

2.2.6.4 Analysis

Sufficient control power was available to hover in crosswinds and tailwinds in winds of 30 knots. The handling qualities, however, when hovering in winds were not as good as those of a standard UH-1B. When hovering in crosswinds a standard UH-1B requires increasing positive (stable) lateral control as wind velocity increases. The UH-1B equipped with floatation landing gear, however, required no change in lateral control to stabilize in crosswinds up to approximately 25 knots. At wind speeds higher than 25 knots, increasing negative (unstable) lateral control was required as wind speed increased.

Hovering characteristics in a tailwind were essentially the same as those of a standard UH-1B. At the critical forward C.G. loading the 10-percent control margin requirement of paragraphs 3.2.1 and 3.3.4 of MIL-H-8501A occurred at a 25-knot wind speed. Above this wind speed very little increase in aft longitudinal control was required; however, wind gusts resulted in the longitudinal control's repeatedly hitting the forward stop. These characteristics would make precision hovering in gusty winds difficult. The UH-1B equipped with floatation landing gear should not be hovered in winds gusting higher than 25 knots and appropriate notation should be included in the Operator's Manual describing the deterioration of handling qualities when hovering with the floatation landing gear installed.

2.2.7 Water Handling Capability

2.2.7.1 Objective

The objective of these tests was to evaluate the capability of and to develop techniques for operating the UH-1B equipped with floatation landing gear on water.

2.2.7.2 Method

The test aircraft was operated on water at gross weights varying from 6600 pounds to 8000 pounds with surface winds varying from zero to 15 knots. Evaluations of starting and shutting down the helicopter, taxiing and turning the aircraft on the water were conducted.

2.2.7.3 Test Results

The test results discussed in paragraph 2.2.7.4, Analysis, are based on the qualitative observations of an experienced engineering test pilot.

2.2.7.4 Analysis

The water handling characteristics were excellent at the water conditions tested.

Four shutdowns to rotor stoppage and subsequent restarts were made. Aircraft heading was easily maintained into the wind as the rotor coasted down after shutdown. Some directional control was maintained as long as the tail rotor was rotating. The aircraft tended to remain streamlined into the wind after rotor motion had stopped. On each restart the aircraft turned through approximately 120 degrees before directional control was effective enough to overcome engagement torque. Directional control became effective

at about 100 rotor rpm. This occurred with smooth application of the throttle, whereas more rapid or abrupt engagements of the throttle resulted in a greater change in heading and required higher rotor rpm before effective directional control was obtained.

Water handling characteristics varied with gross weight or float depth in the water. Float depth varied from approximately 1/3 of the float underwater at 6500 pounds to slightly over 1/2 of the floatation landing gear submerged at 8000 pounds. The float depth at 8000 pounds was considered to be a practical limit. Taxiing was easily accomplished, with no tendency of the aircraft to tip at any weight. Taxi ground speeds of approximately 6 knots at 8000 pounds to 10 knots at 6500 pounds were possible without nose tuck's becoming severe due to the front of the float "digging in." This taxi speed was increased by pulling collective pitch and thereby decreasing float depth. Ground speeds approaching 15 knots were obtained through this method. On a downward taxi with the wind over 3 knots it was difficult to decelerate and stop the aircraft through the use of aft cyclic control without applying significant collective pitch. Crosswind taxi presented no difficulties and was easily accomplished by deflecting the lateral cyclic control into the wind and controlling the heading with the pedals. Generally, as weight was increased the aircraft became more sluggish in water maneuvering; however, this assisted in handling the aircraft in higher wind conditions and manifested itself as an apparent increase in stability.

No evaluation was made with the aircraft in flowing water or in water conditions greater than Sea State 1 due to nonavailability of a suitable test area.

Hazards peculiar to water operation include very poor depth perception over smooth water for all flight conditions and difficulty in determining relative motion of the helicopter due to wave motion created by the downwash. Depth perception is considerably improved by waves. When a landing is anticipated on calm water, a low pass to agitate the water is desirable when practical.

Appropriate notation should be inserted in the Operator's Manual describing the techniques for handling the UH-1B equipped with floatation landing gear on water.

SECTION 3. APPENDICES

APPENDIX I

TEST DATA

Figure No. 1

Non-Dimensional Hovering Performance

UH-1B USA S/N 60-3548 Float Equipped

Density Altitude = 3000 FT.

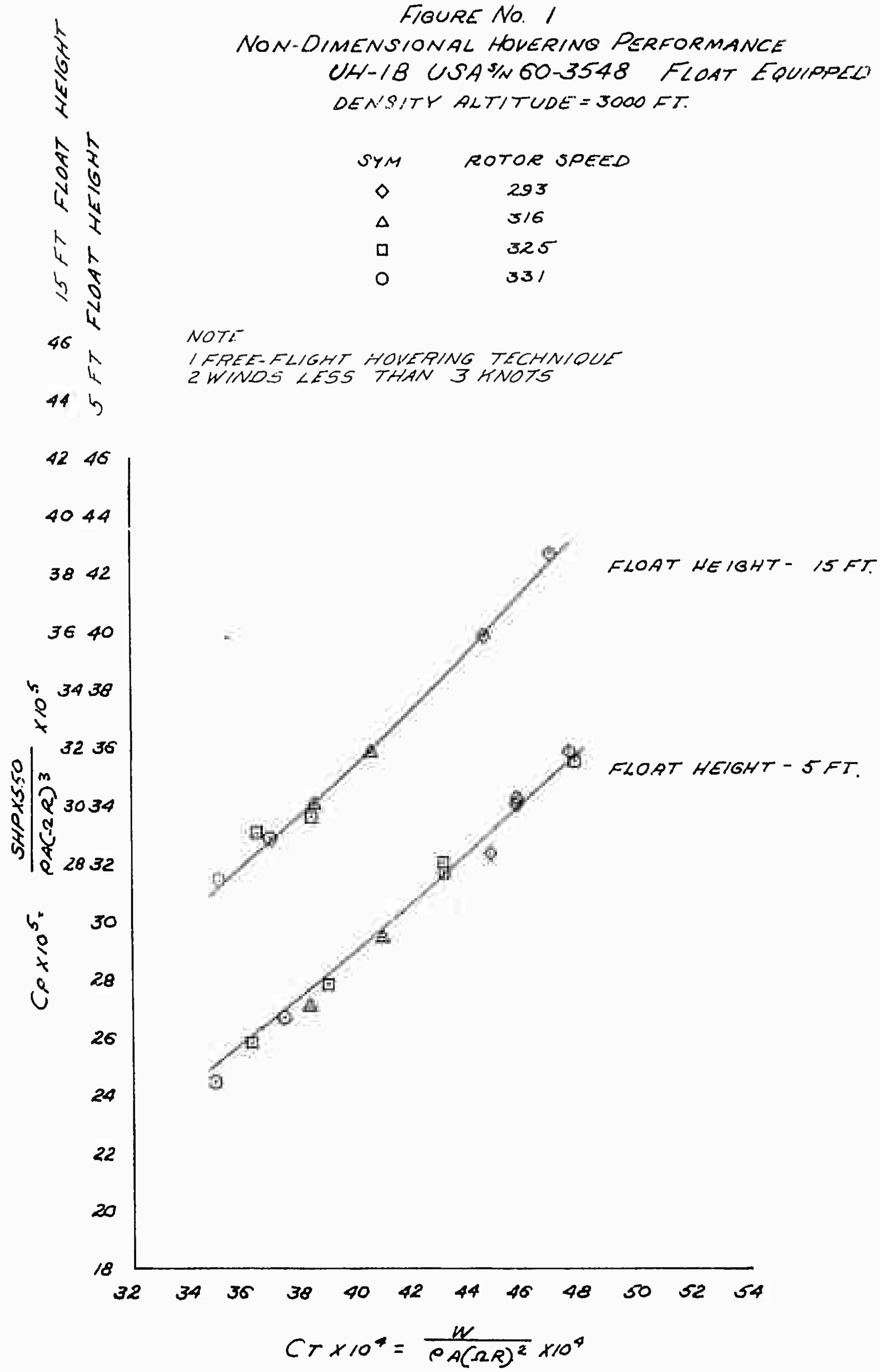


FIGURE NO. 2
CLIMB PERFORMANCE
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED
GROSS WEIGHT = 6600 LBS ROTOR SPEED = 324 RPM
CG LOCATION 130.8 (MID)
STANDARD DAY

NOTE
1 SHP AVAILABLE OBTAINED FROM BHC-204-099-712
2 FUEL FLOW OBTAINED FROM BHC-204-099-712

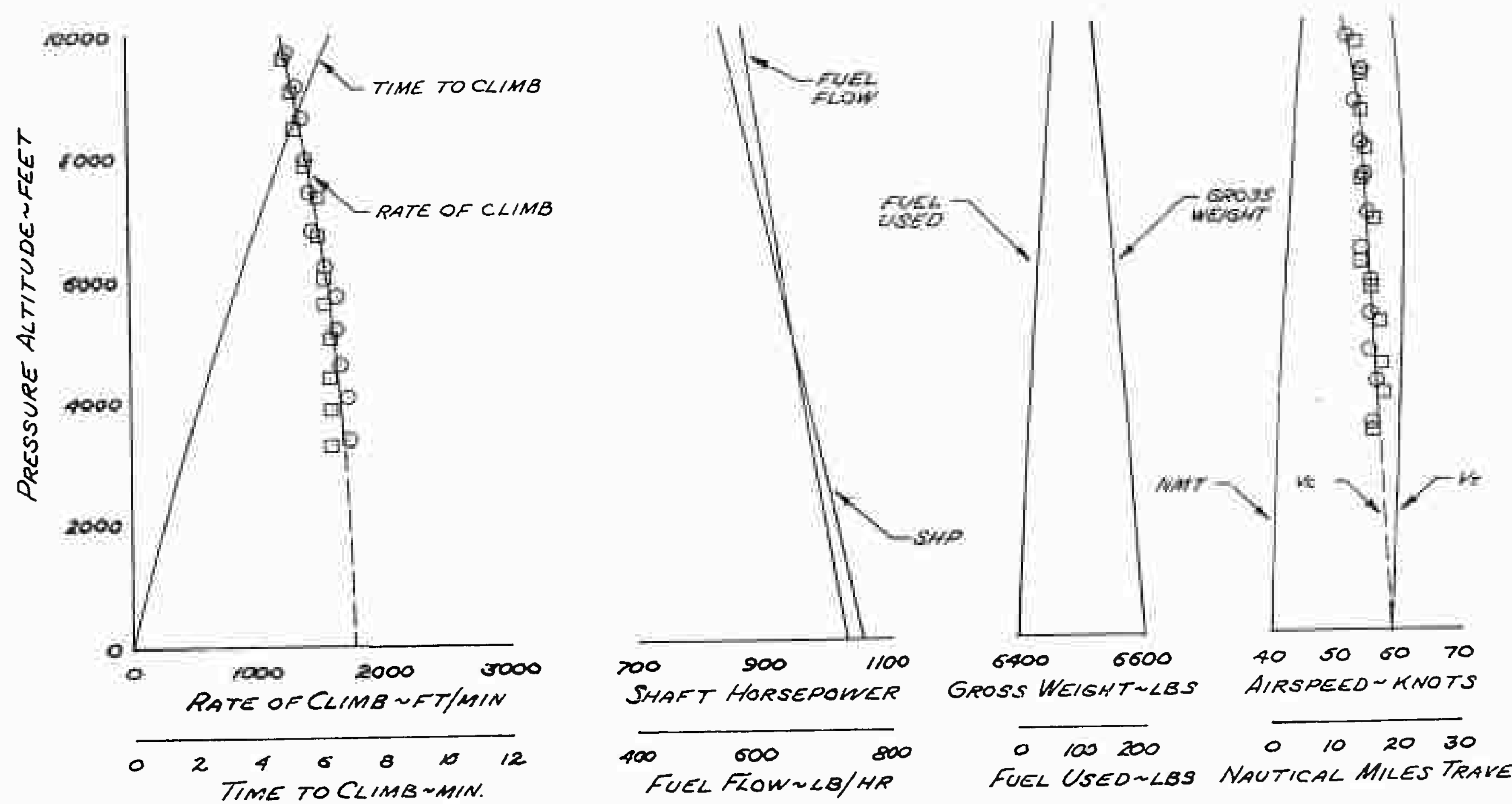


FIGURE No. 3
CLIMB PERFORMANCE
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED
GROSS WEIGHT = 7660 LBS ROTOR SPEED = 324 RPM
CG LOCATION 131 (MID)
STANDARD DAY

NOTE
1 SHP AVAILABLE OBTAINED FROM BHC-204-099-712
2 FUEL FLOW OBTAINED FROM BHC-204-099-712

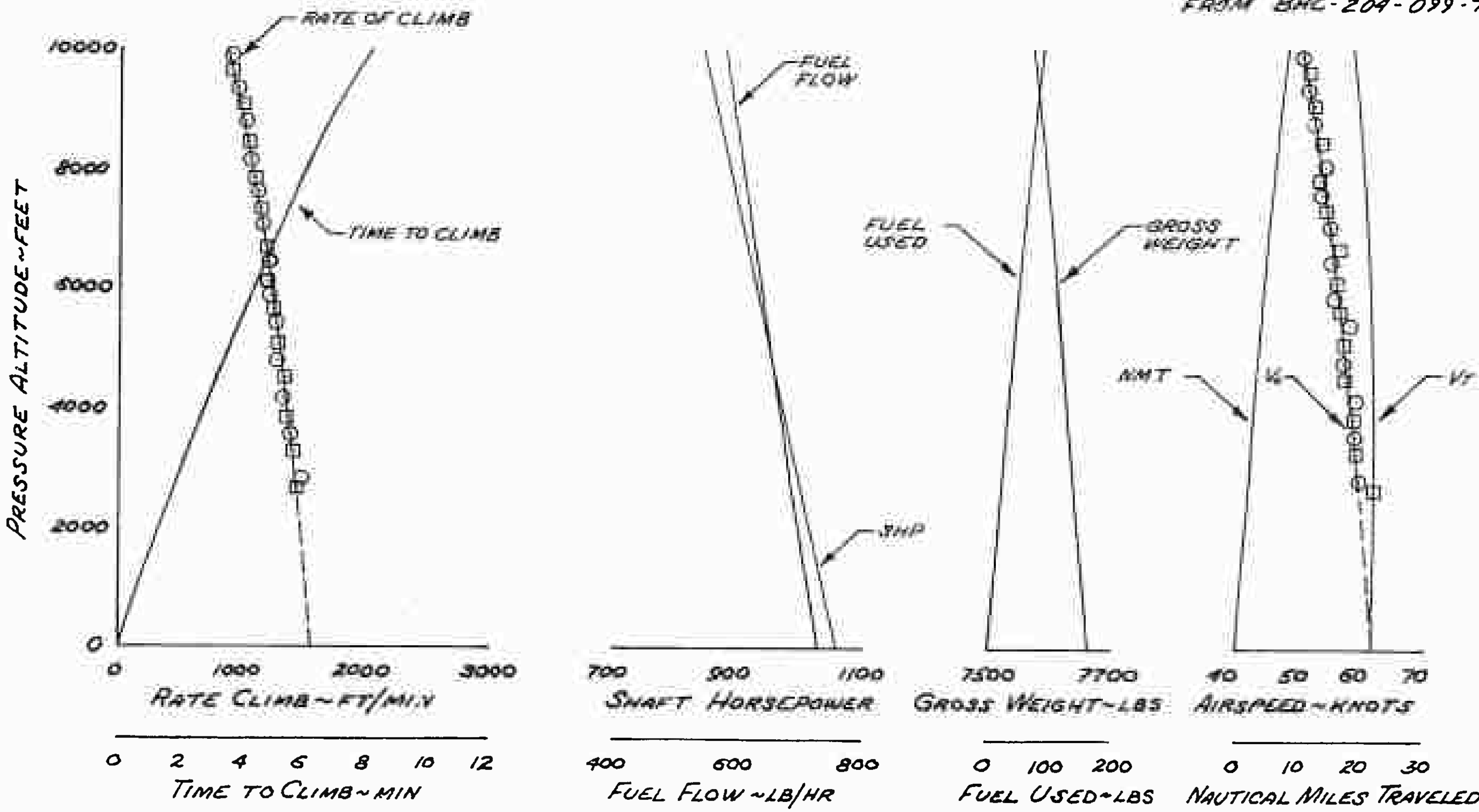


FIGURE No. 4
NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED

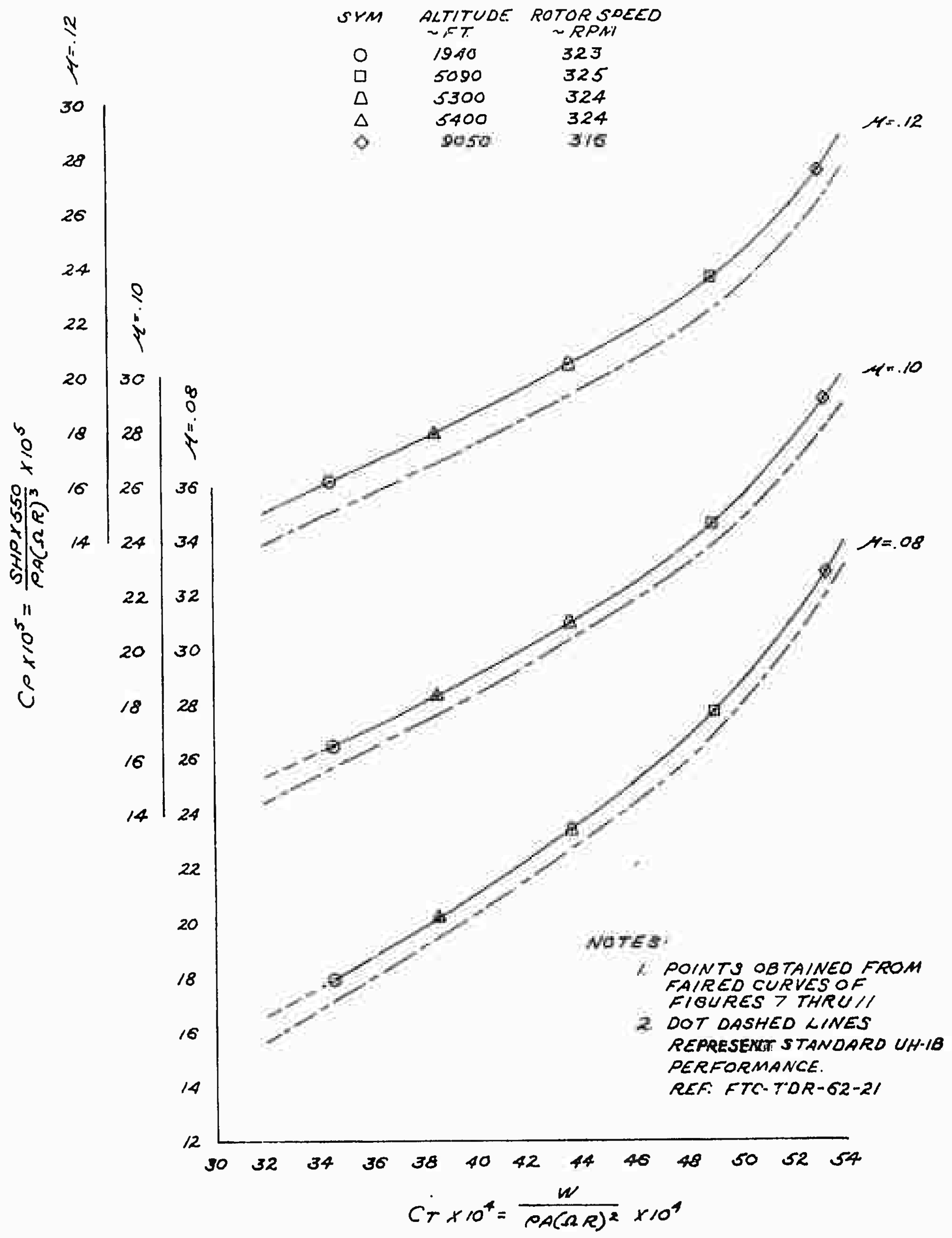


FIGURE No. 5

NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE

UH-1B USA S/N 60-3548

FLOAT KIT INSTALLED

SYM	ALTITUDE ~ FT.	ROTOR SPEED ~RPM
○	1940	323
□	5090	325
◮	5300	324
△	5400	324
◇	9050	316

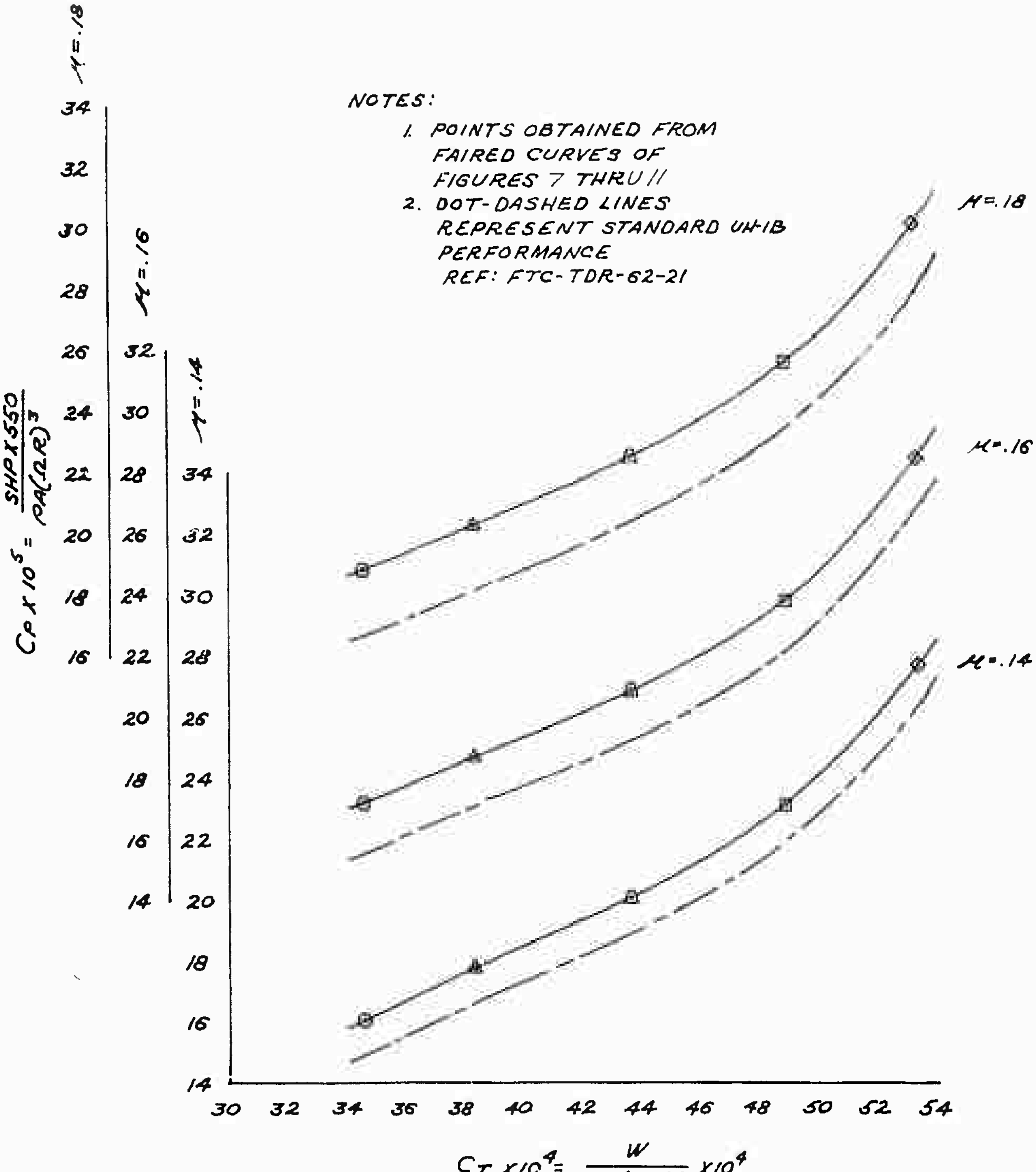


FIGURE NO. 6
NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED

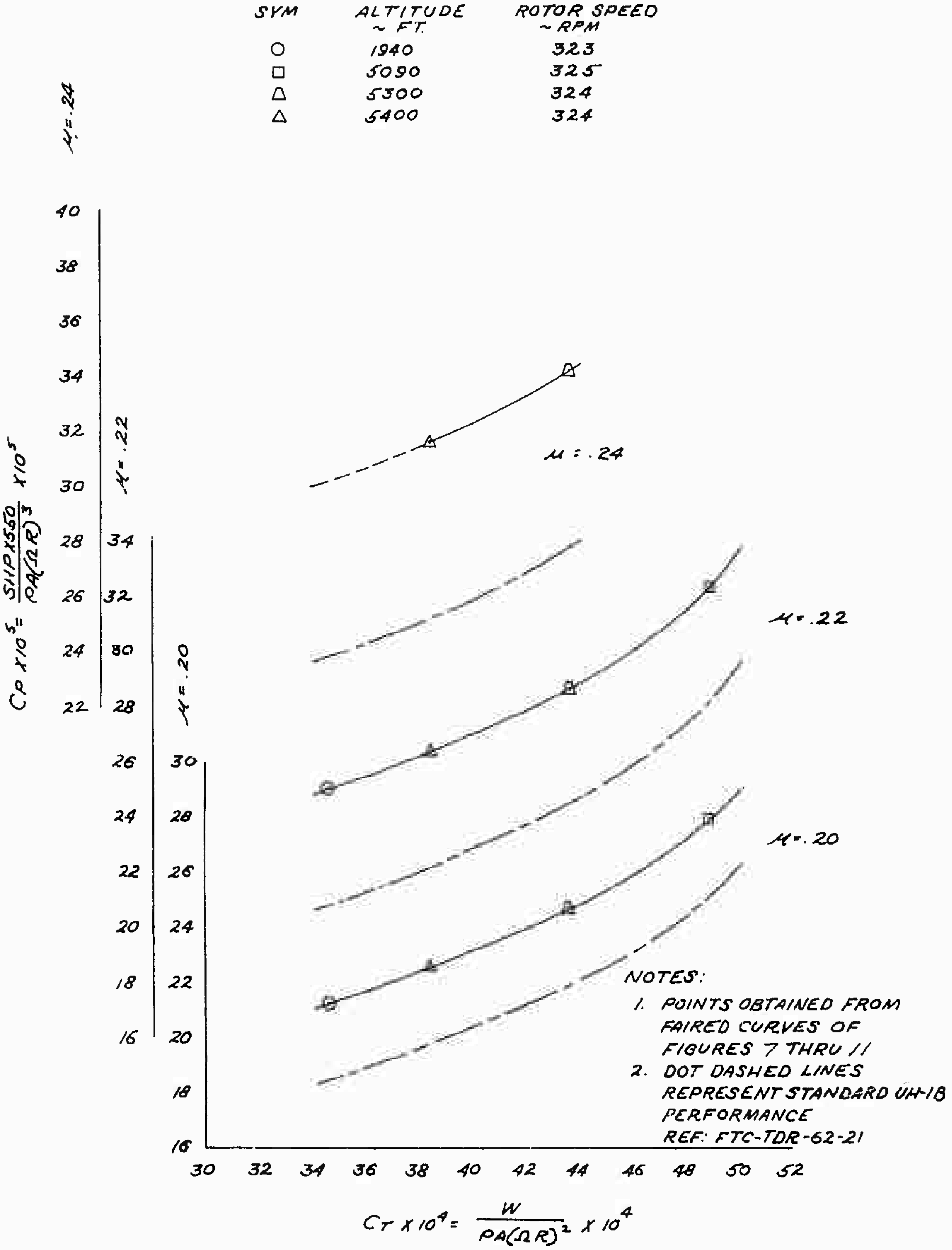


FIGURE NO. 7
LEVEL FLIGHT PERFORMANCE
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED

GROSS WEIGHT	6520 LBS.
ALTITUDE	1940 FT.
ROTOR SPEED	323 RPM
C_T	.003449
CG STATION	131.4 IN. (MID)

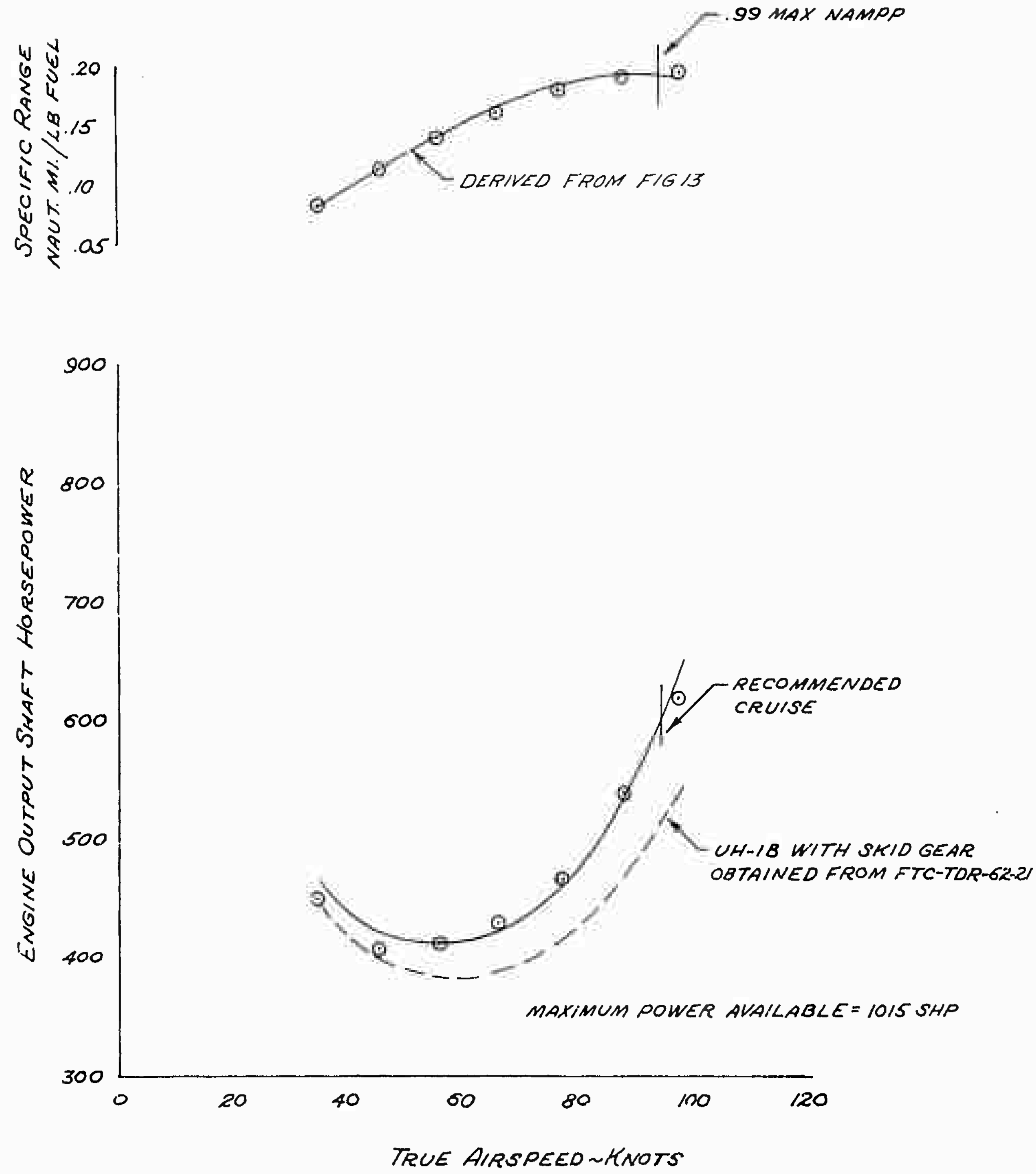


FIGURE No. 8
LEVEL FLIGHT PERFORMANCE
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED

GROSS WEIGHT	6600 LB
ALTITUDE	5400 FT
ROTOR SPEED	324 RPM
C_T	.003835
CG STATION	130 IN. (MID)

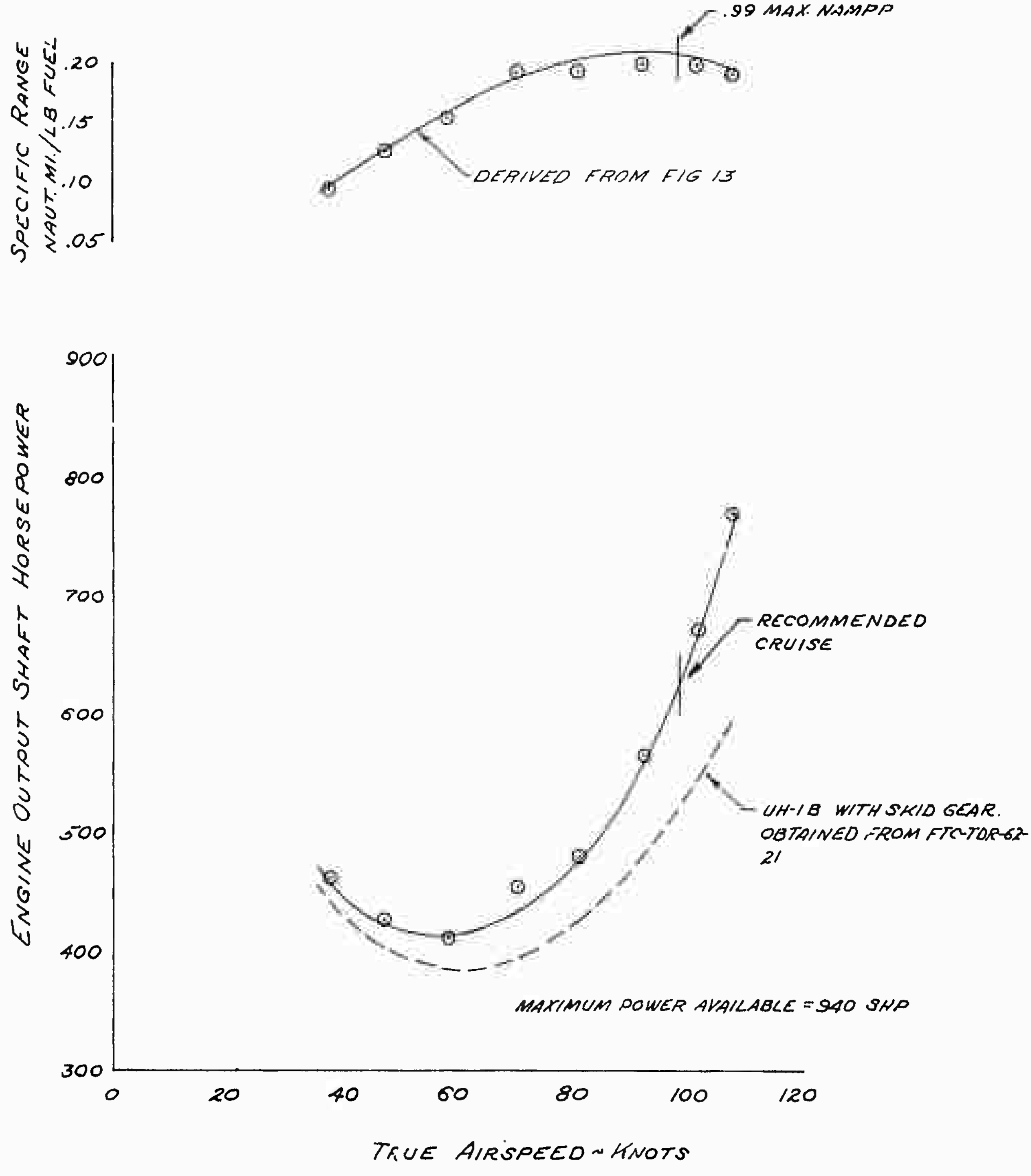


FIGURE No. 9
LEVEL FLIGHT PERFORMANCE
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED

GROSS WEIGHT	7600 LBS
ALTITUDE	5300 FT.
ROTOR SPEED	324 RPM
C_T	.004361
CG STATION	129.8 IN. (MID)

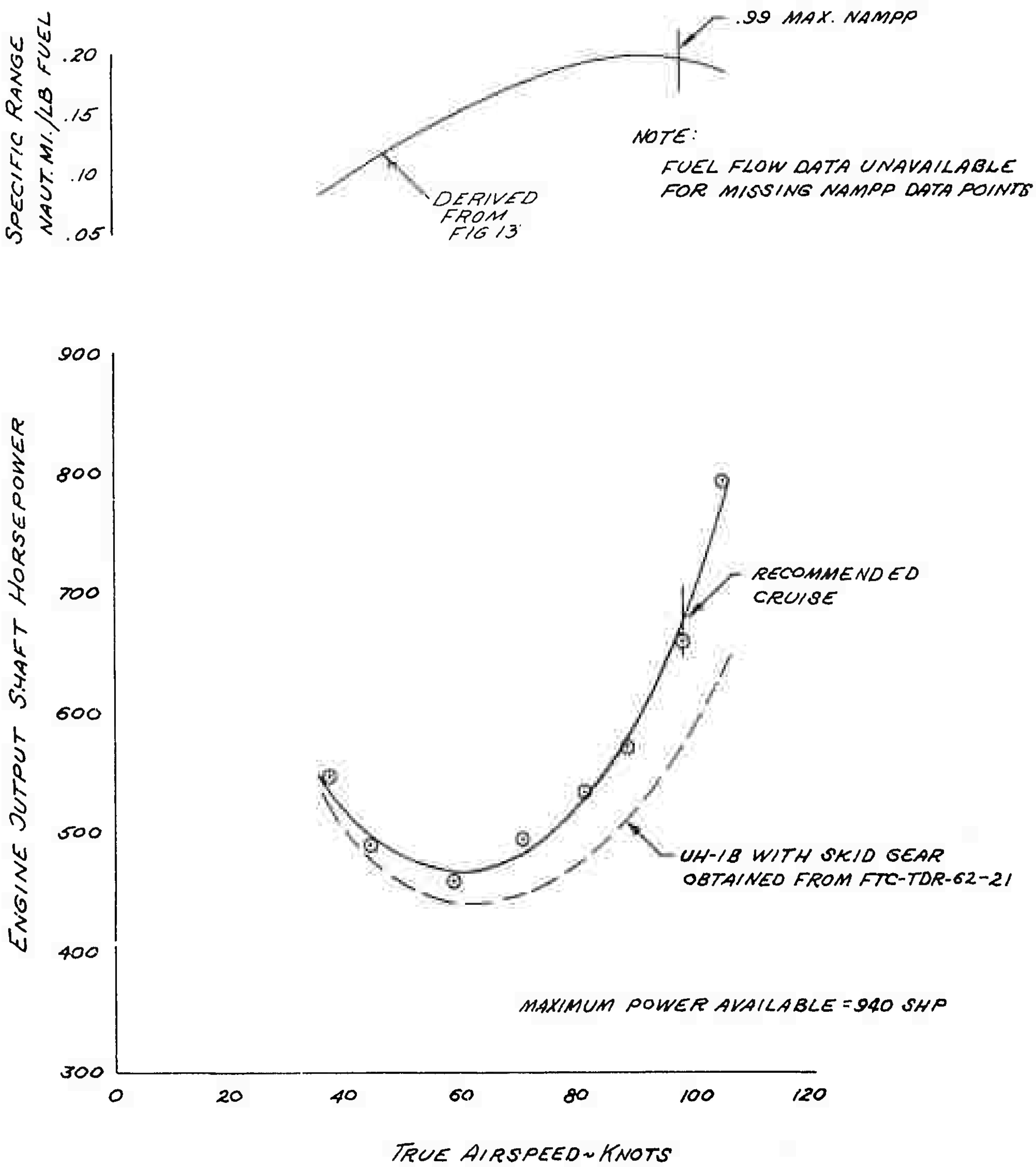


FIGURE No. 10
LEVEL FLIGHT PERFORMANCE
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED

GROSS WEIGHT	8510 LBS.
ALTITUDE	5090 FT.
ROTOR SPEED	325 RPM
C_T	.004889
CG STATION	128.2 IN. (MID)

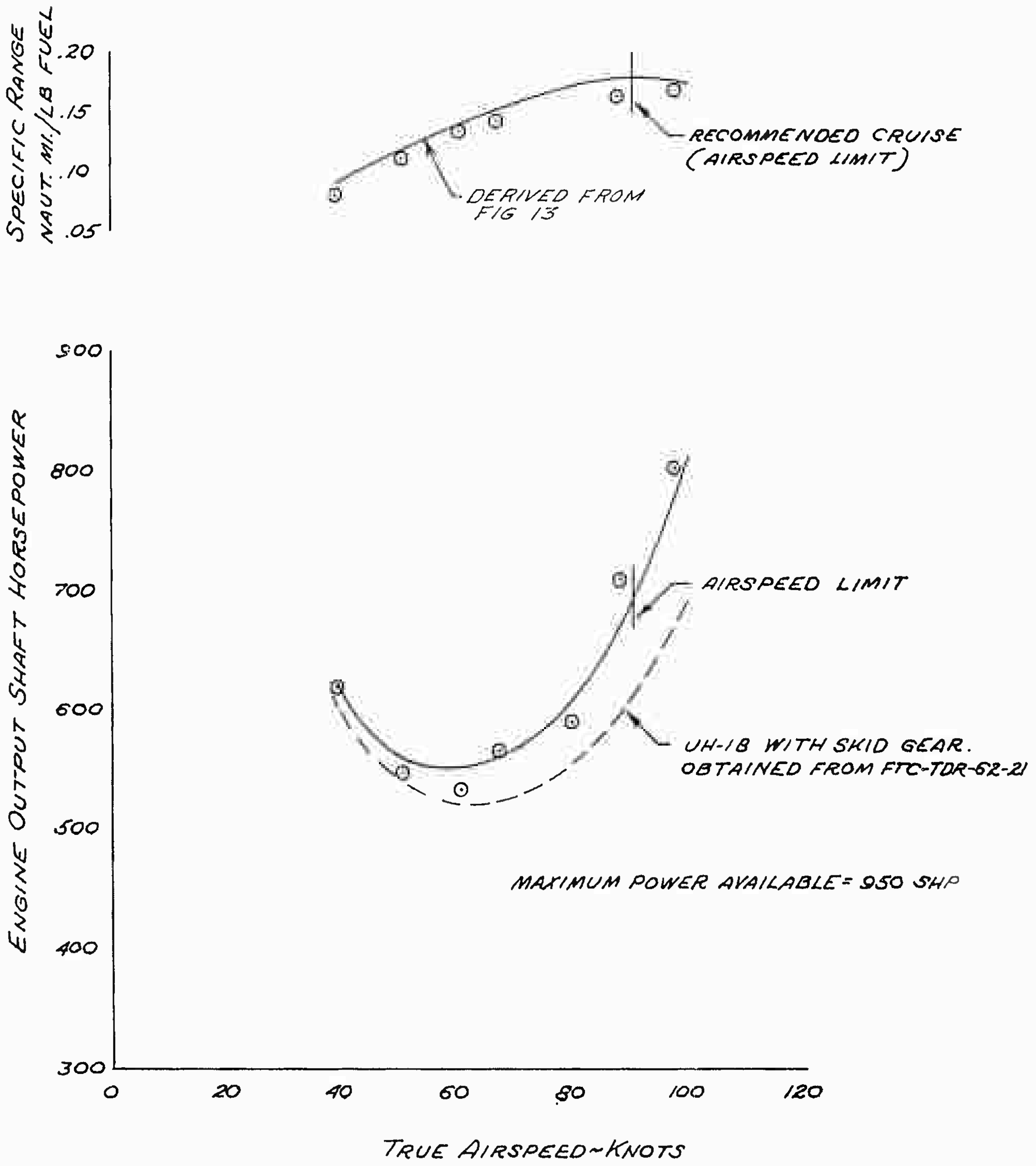


FIGURE NO. 11
LEVEL FLIGHT PERFORMANCE
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED

GROSS WEIGHT	7760 LBS
ALTITUDE	9050 FT.
ROTOR SPEED	316 RPM
C_T	.005329
CG STATION	132.3 IN. (MID)

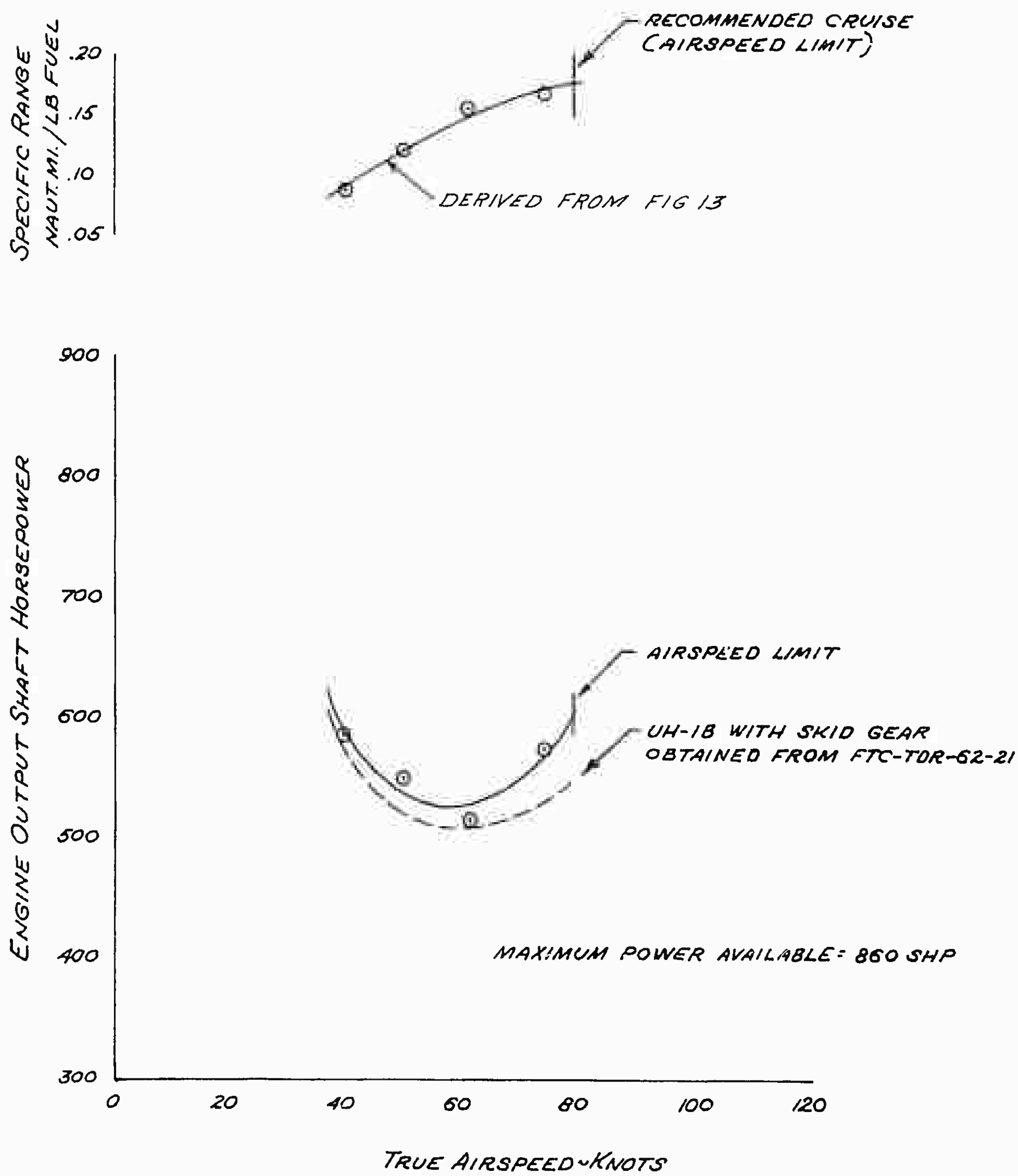
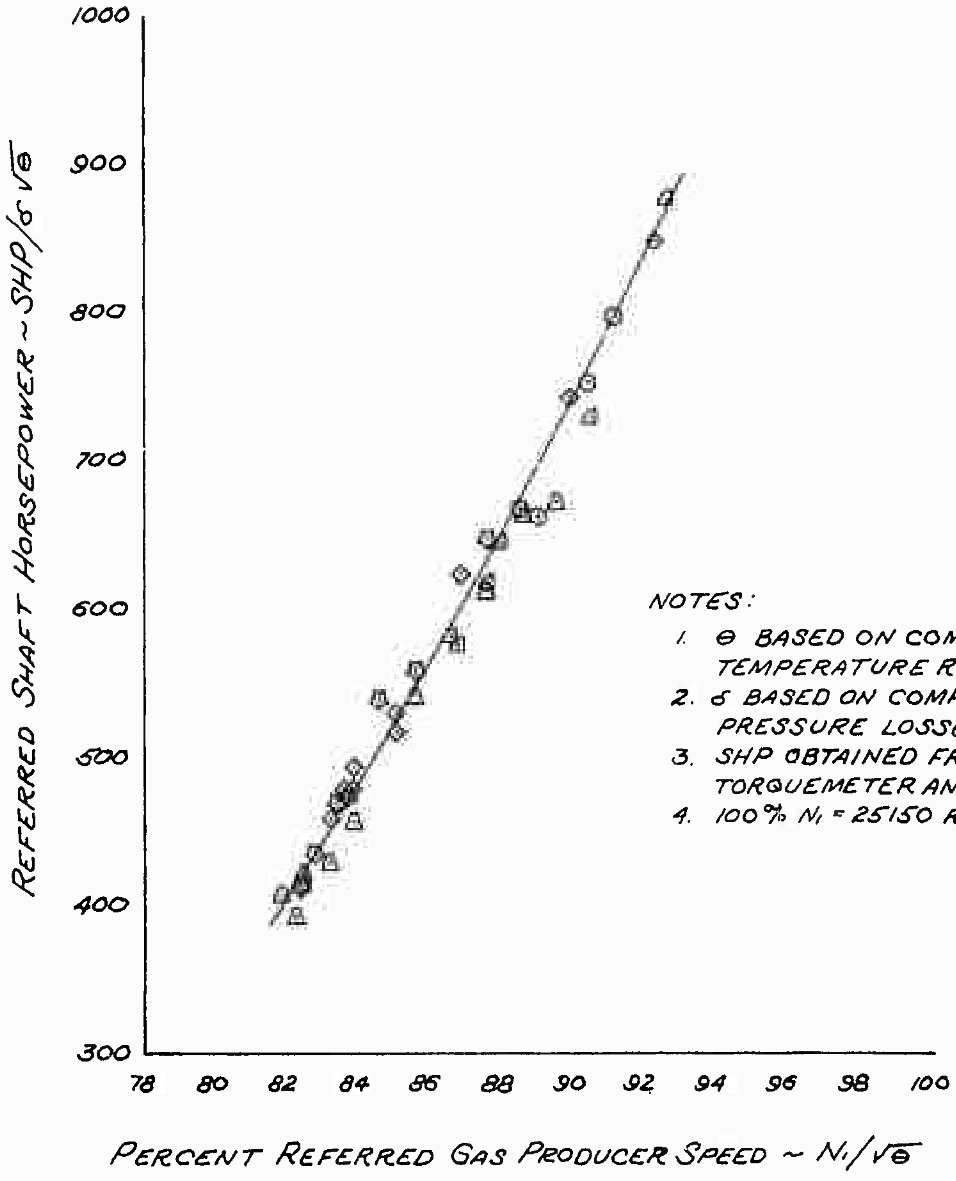


FIGURE No. 12
ENGINE CHARACTERISTICS
UH-1B USA S/N 60-3548
T-53-L-9A S/N LEO-6309

SYM	H_D ~FT	ROTOR SPEED ~RPM	N_{II} ~RPM
⬠	1940	324	6606
◁	5090	324	6606
△	5300	324	6606
◇	5400	324	6606
○	9050	316	6442



NOTES:
1. θ BASED ON COMPRESSOR INLET TEMPERATURE RISE$(T_{T_I} - T_{AMB}) = 2°C$
2. δ BASED ON COMPRESSOR INLET PRESSURE LOSS$(P_{T_I}/P_{AMB}) = 1.00$
3. SHP OBTAINED FROM ENGINE TORQUEMETER AND ENGINE CALIBRATION.
4. 100% N_1 = 25150 RPM.

FIGURE NO. 13
ENGINE CHARACTERISTICS
UH-1B USA S/N 60-3548
T-53-L-9A S/N LEO-6309

SYM	H_D ~FT	ROTOR SPEED ~RPM	N_{II} ~RPM
⬠	1940	324	6606
□	4780	314	6402
◿	5090	324	6606
0	5240	324	6606
△	5300	324	6606
◇	5400	324	6606
△	5480	323	6585
⬡	9050	316	6442
○	9780	315	6422

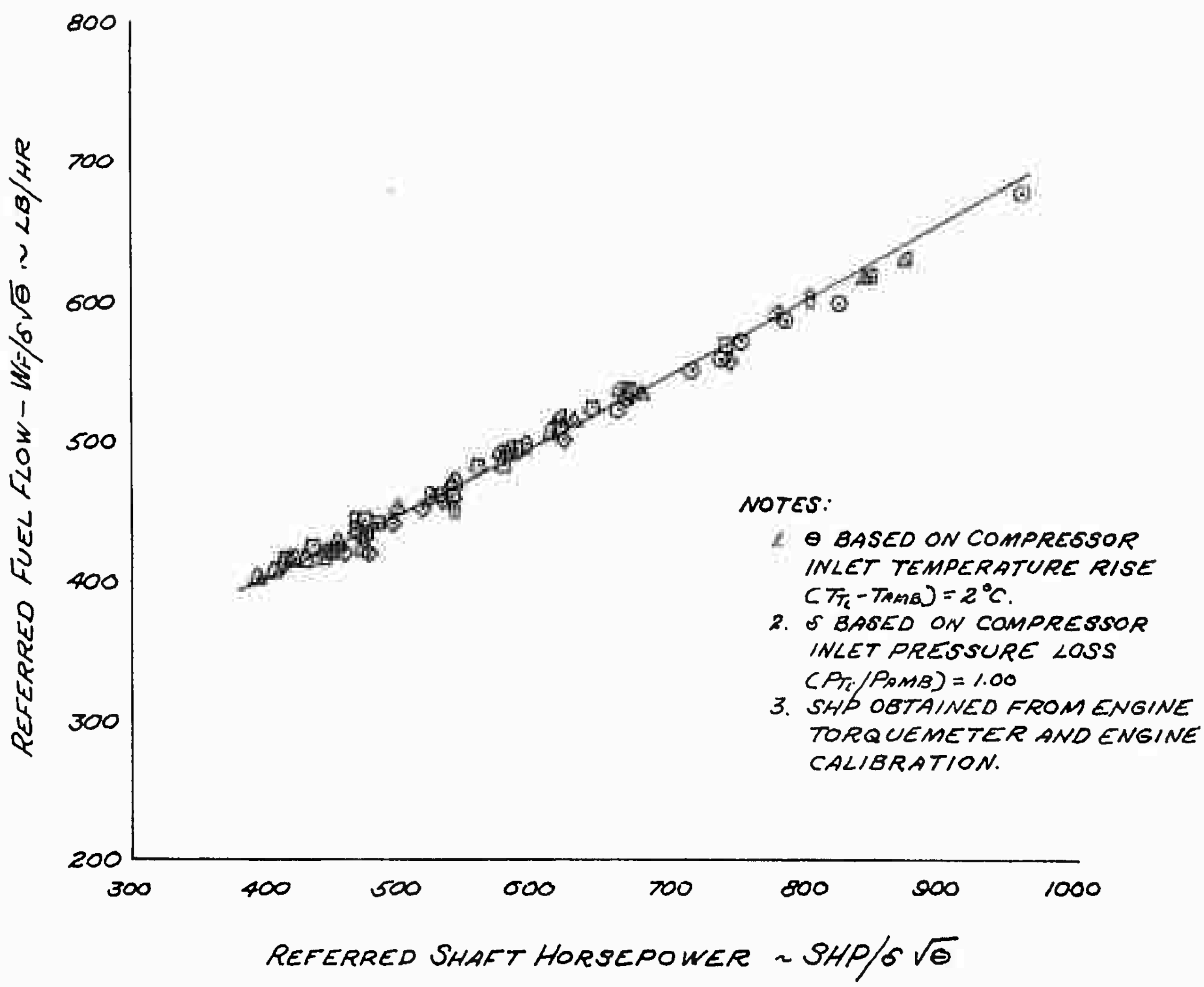


FIGURE NO. 14
AUTOROTATIONAL CHARACTERISTICS
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED
AVERAGE GROSS WT= 6600 LBS ROTOR RPM= 324
CG LOCATION= 131.0 IN. (MID)

SYM	DENSITY ALT. ~FT.
○	5000
□	10000

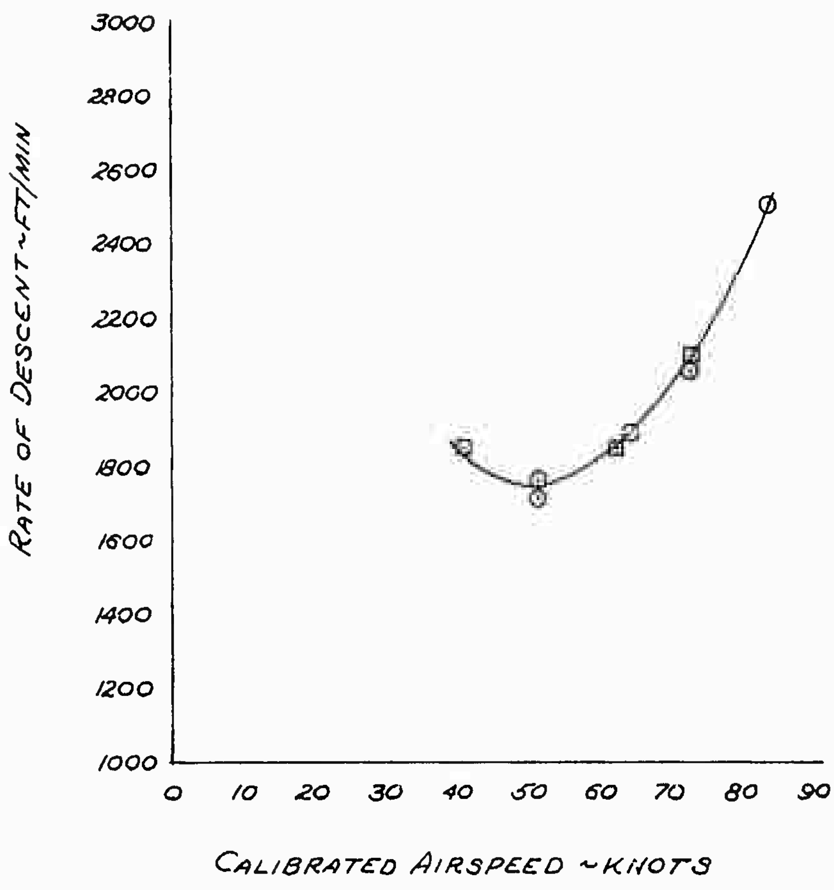


FIGURE No. 15
ALTITUDE RECOMMENDED FOR SAFE
AUTOROTATIONAL LANDING
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED
ROTOR RPM AT THROTTLE CHOP - 324
DENSITY ALTITUDE - 3000 FT.
GROSS WEIGHT - 8000 LB.

SYM	FLIGHT CONDITION	
○	LEVEL FLIGHT -	2 SEC. COLLECTIVE DELAY
□	CLIMB OUT -	NO COLLECTIVE DELAY

WIND LESS THAN 3 KNOTS

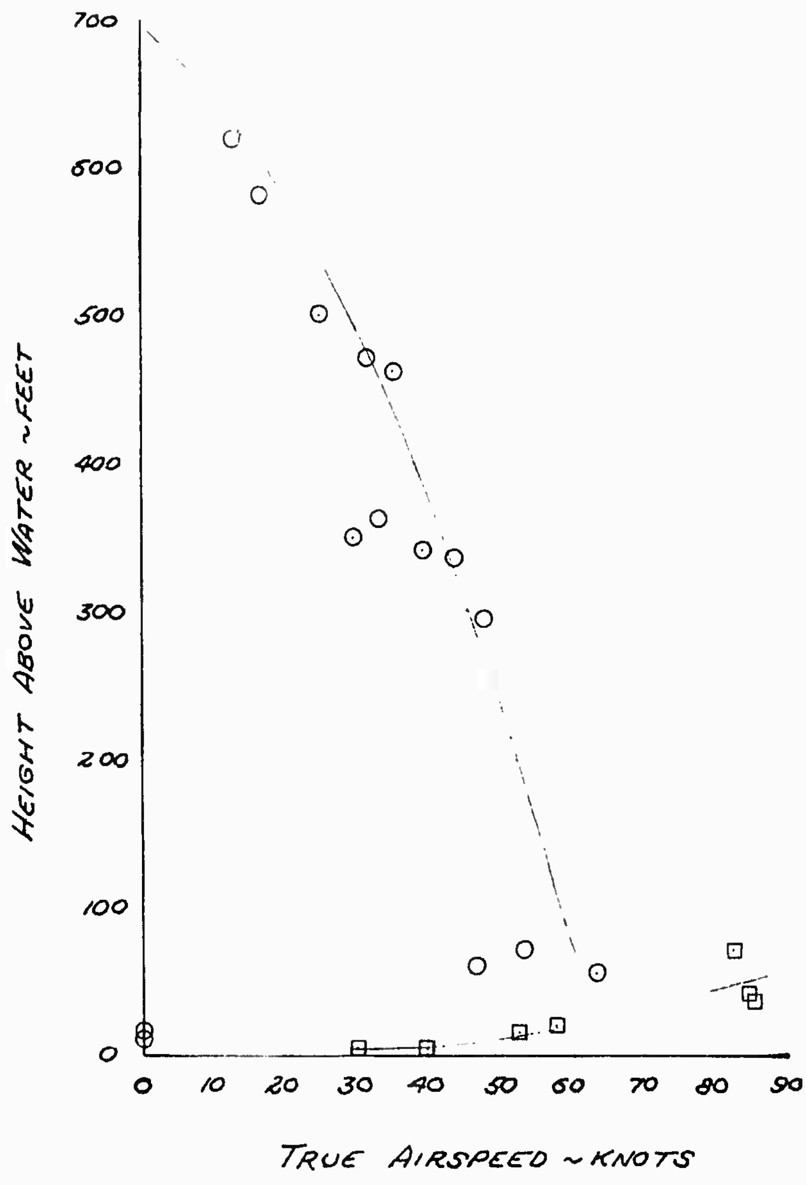


FIGURE No. 16
AIRSPEED CALIBRATION
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED
TRAILING BOMB METHOD

DENSITY ALT - 5000 FT
GROSS WT. 6600 LB
CG LOCATION 131 IN. (MID)
LEVEL FLIGHT

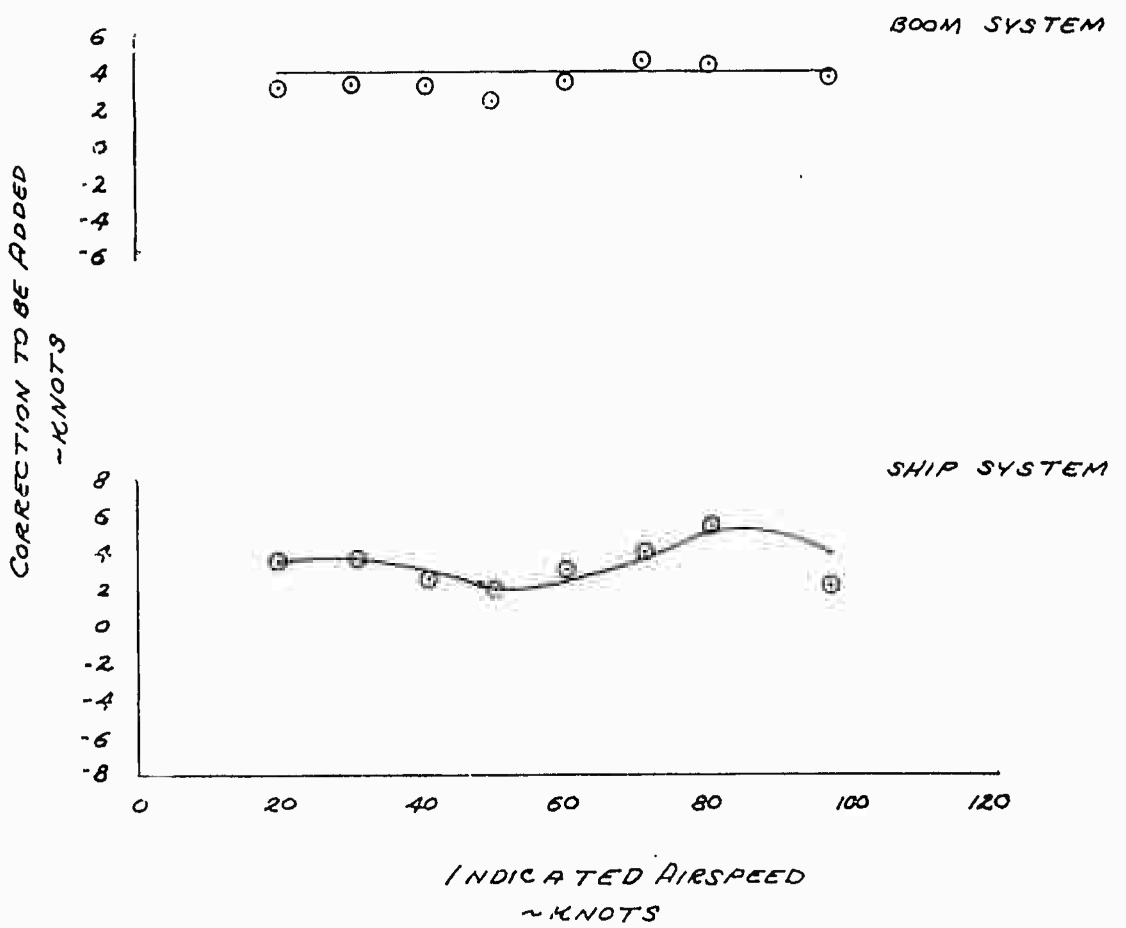


FIGURE NO 17
CONTROL POSITIONS IN LEVEL FLIGHT
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED
DENSITY ALTITUDE = 1940 FT. GROSS WEIGHT = 6630 LB
ROTOR SPEED = 323 RPM CG LOCATION - 131.4 IN. (MID)

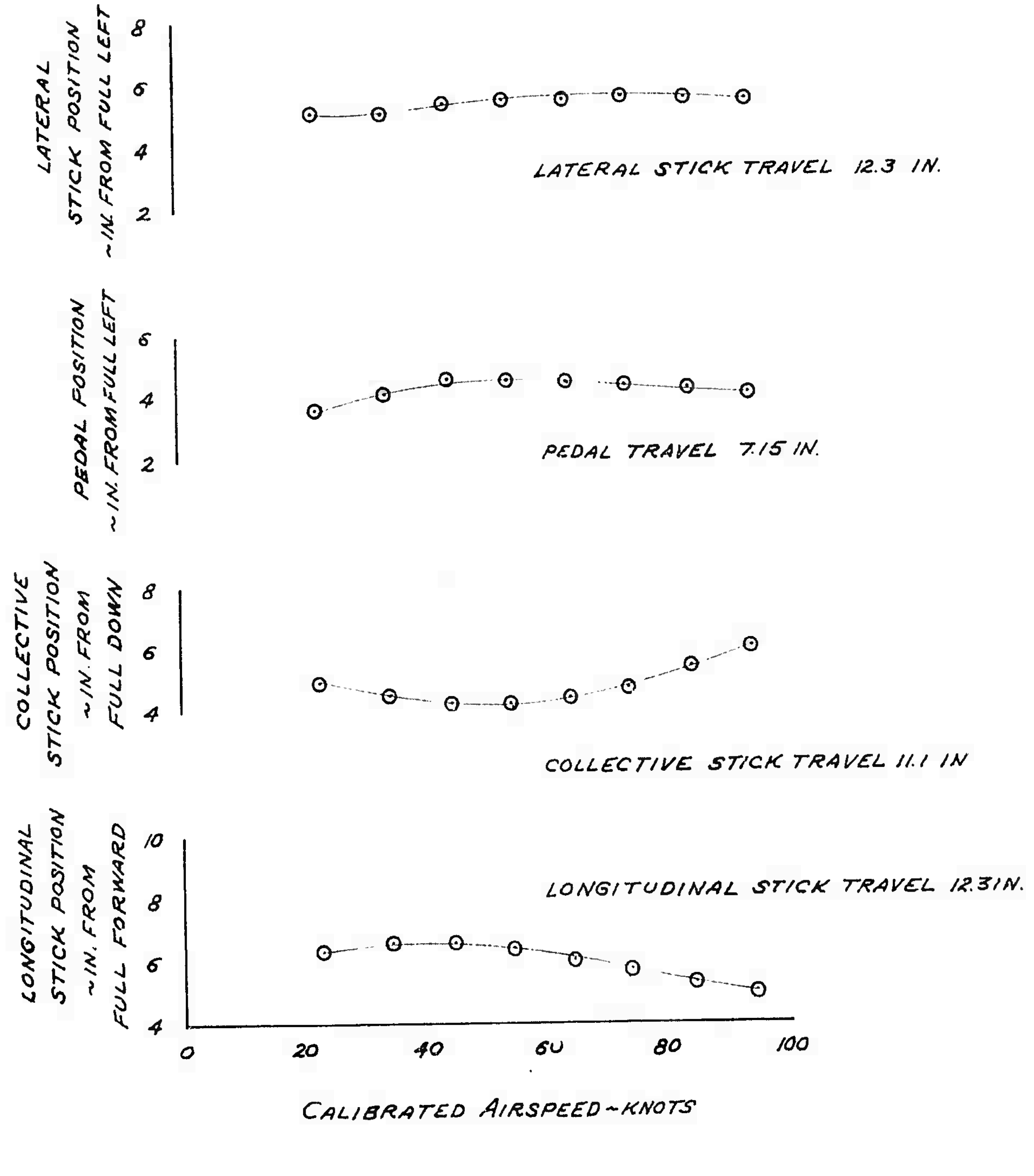


FIGURE NO. 18
CONTROL POSITIONS IN LEVEL FLIGHT
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED
DENSITY ALTITUDE = 5300   GROSS WEIGHT = 6490
ROTOR SPEED = 324 RPM   CG LOCATION 134 IN. AFT

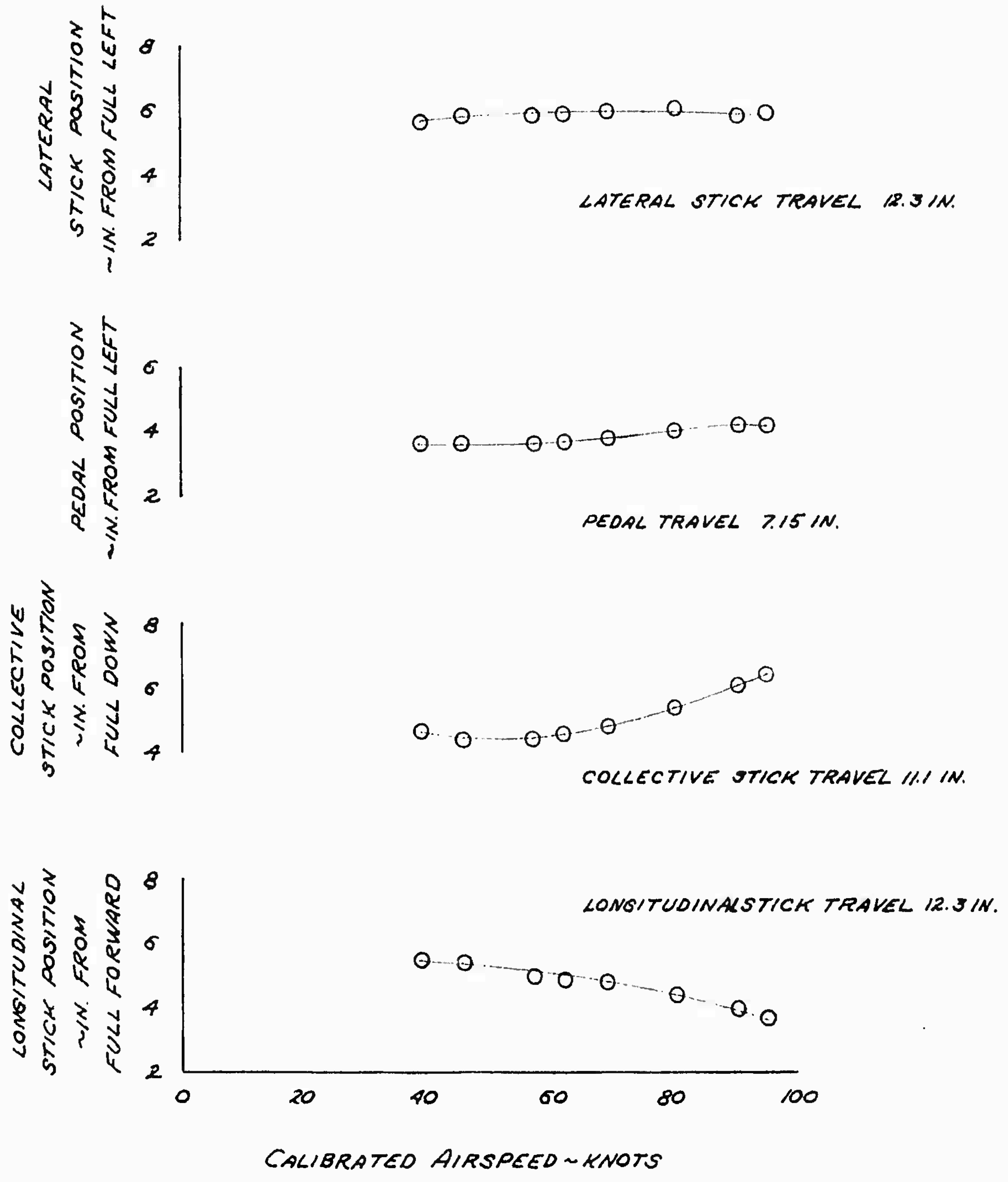


Figure No. 19
Control Positions in Level Flight
UH-1B USA S/N 60-3548
Float Kit Installed
Density Altitude=5090 Gross Weight=8510
Rotor Speed=325RPM CG Location 128.2IN FWD

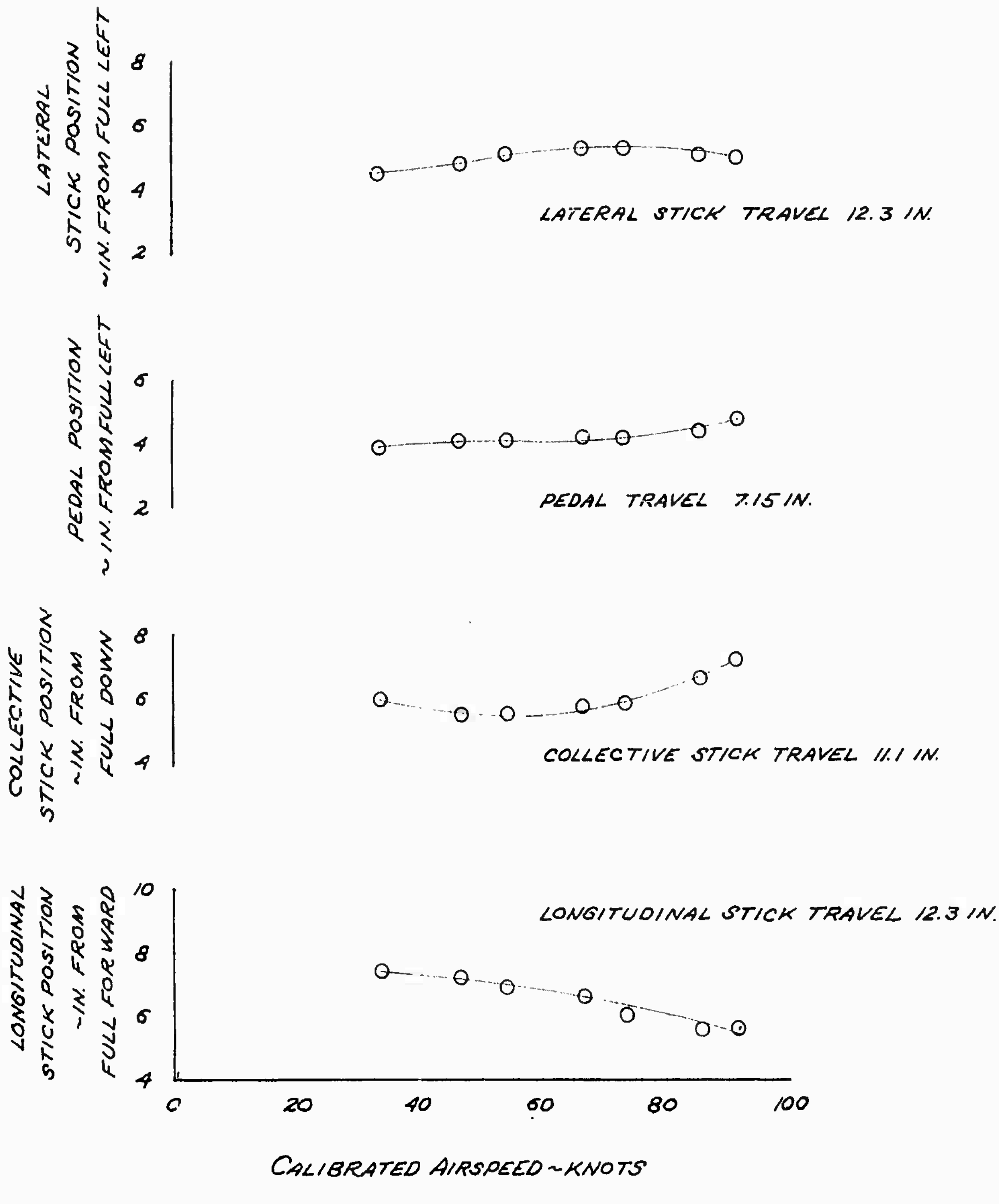


FIGURE No. 20

STATIC LONGITUDINAL STABILITY

UH-1B USA S/N 60-3548

FLOAT KIT INSTALLED

ROTOR SPEED = 324 RPM

CLIMB AND AUTOROTATION

SYM	DENSITY ALT ~FT	GROSS WEIGHT ~LB	CG LOCATION ~IN	
○	5000	6620	133.6(AFT)	CLIMB
□	6000	6460	133.5(AFT)	AUTOROTATION

NOTE:

1 SHADED SYMBOLS DENOTE TRIM CONDITIONS

2 COLLECTIVE CONTROL HELD CONSTANT AT TRIM VALUE

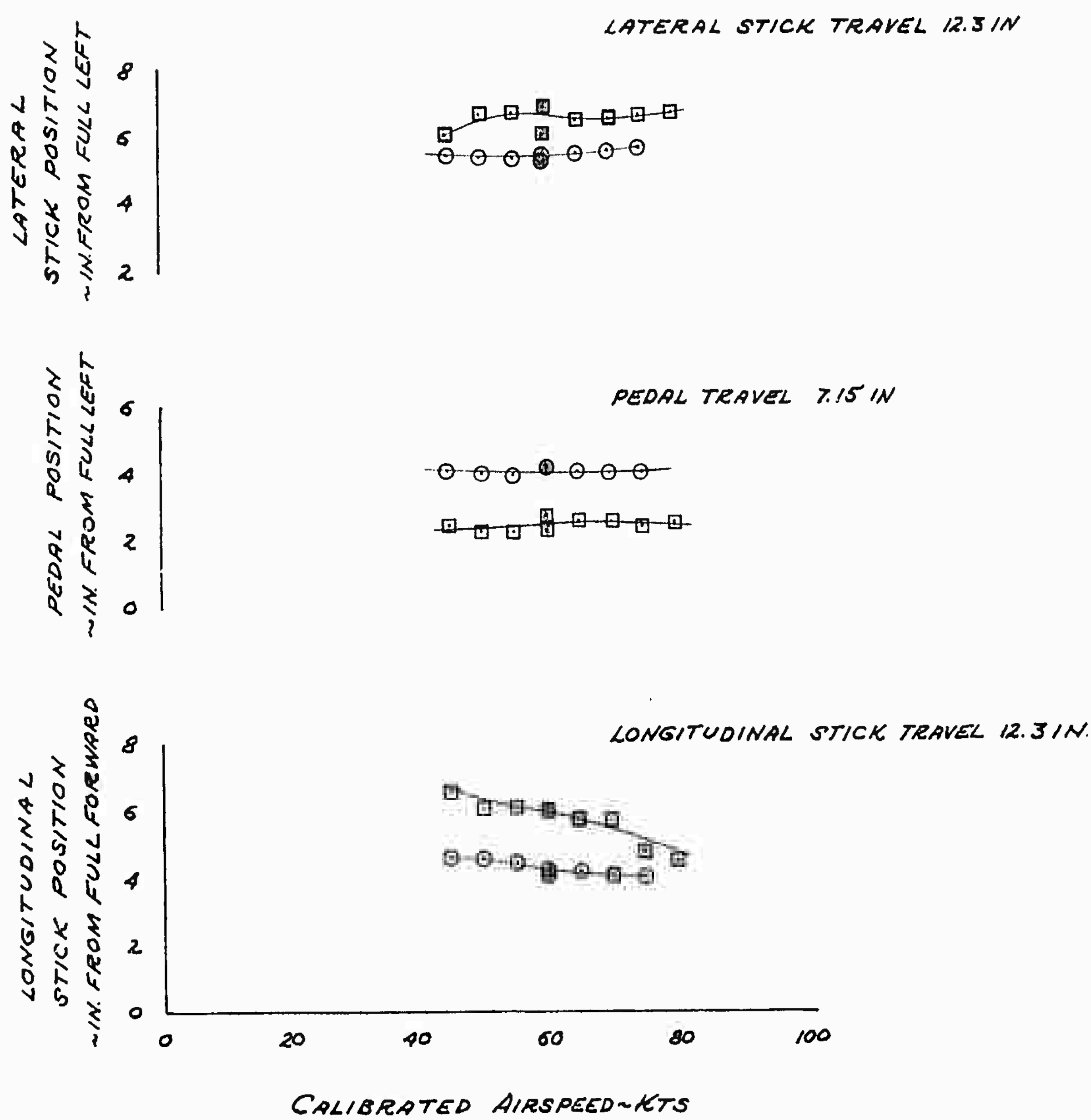


FIGURE No. 21
STATIC LONGITUDINAL STABILITY
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED
ROTOR SPEED = 324 RPM
LEVEL FLIGHT

SYM	DENSITY ALT ~ FT	GROSS WEIGHT ~ LB	CG LOCATION ~ IN
○	5000	6570	133.6 (AFT)
□	5000	6450	133.5 (AFT)

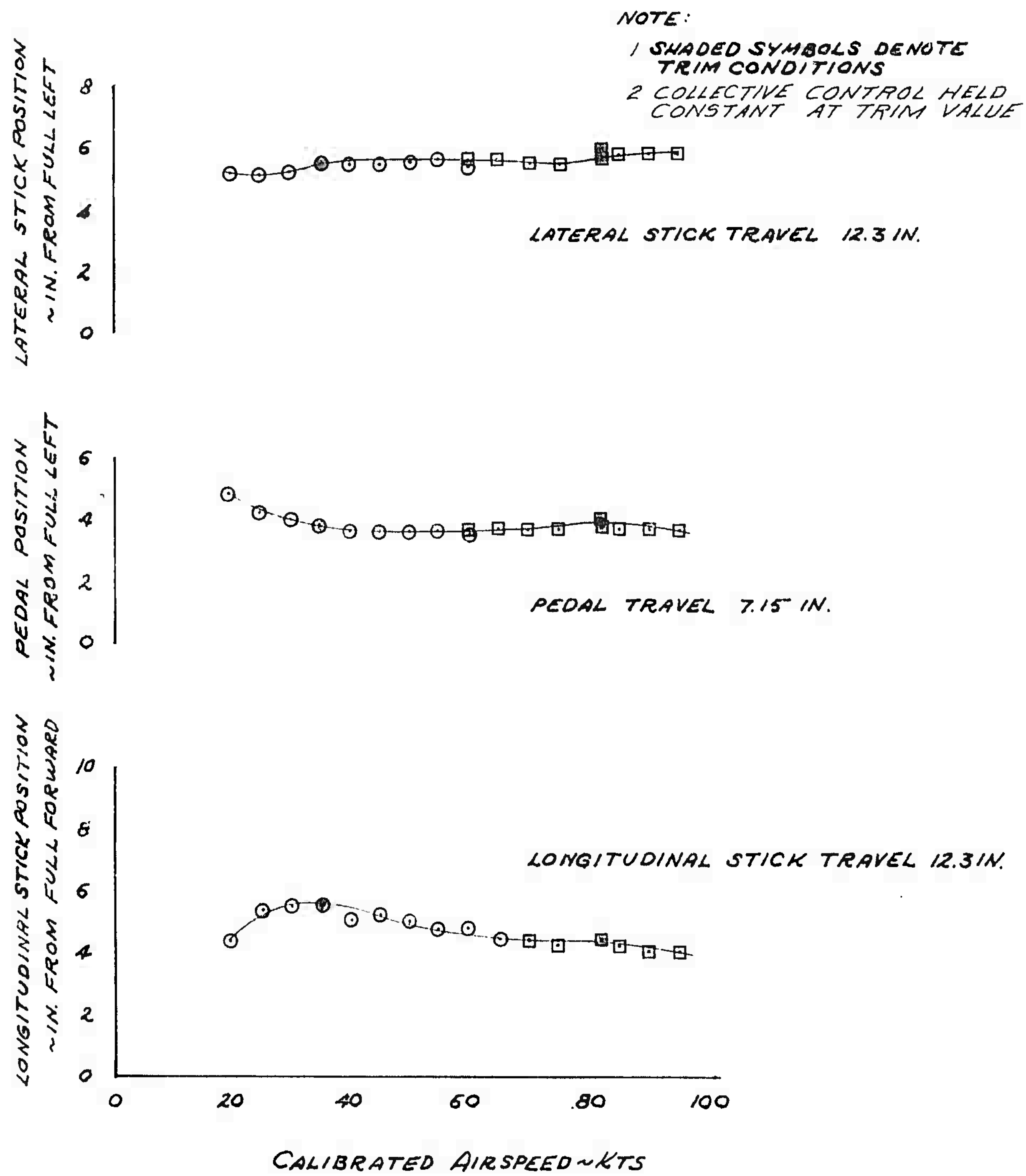


FIGURE NO 22

STATIC LATERAL-DIRECTIONAL STABILITY

UH-1B USA S/N 60-3548

FLOAT KIT INSTALLED

DENSITY ALTITUDE = 5000 FT. GROSS WEIGHT = 6840 LB

CALIBRATED AIRSPEED = 35 KTS ROTOR SPEED = 324 RPM

CG LOCATION - 127.2 IN (FWD)

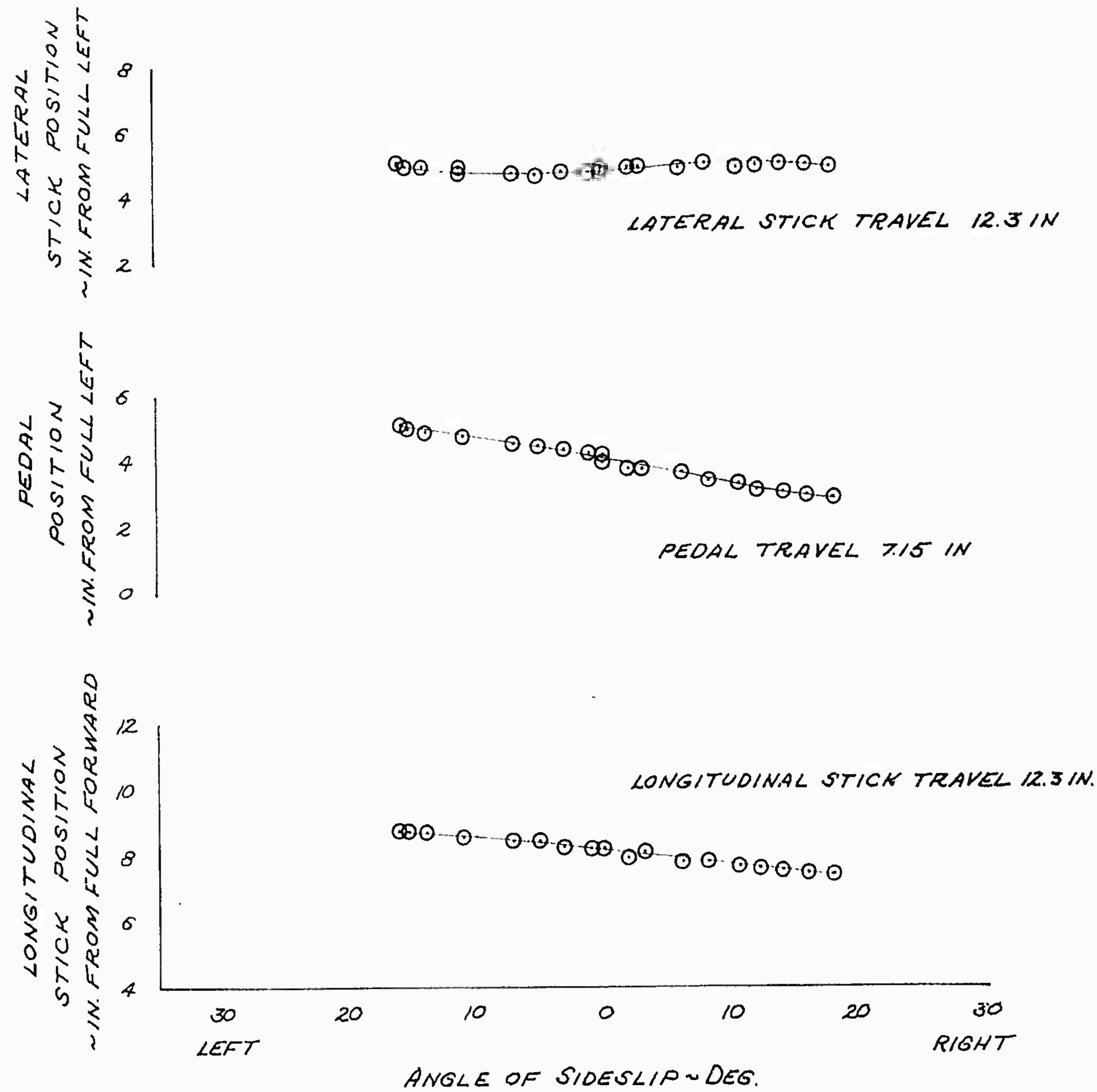


FIGURE NO. 23
STATIC LATERAL-DIRECTIONAL STABILITY
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED
DENSITY ALTITUDE = 5000 FT. GROSS WEIGHT = 6690 LB.
CALIBRATED AIRSPEED = 75 KTS ROTOR SPEED = 324 RPM
CG LOCATION - 127.0 IN. (FWD)

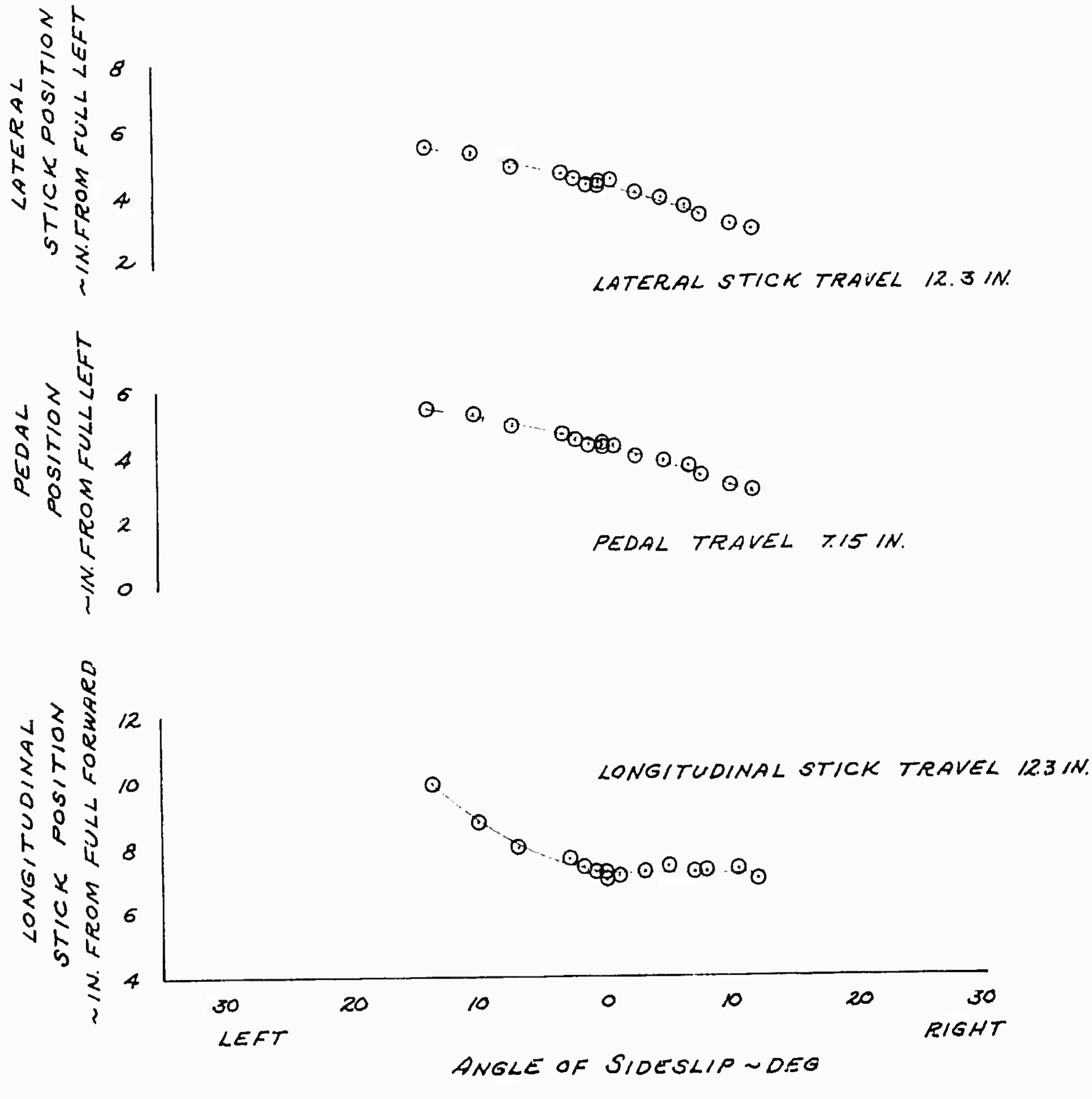


FIGURE NO. 24
STATIC LATERAL-DIRECTIONAL STABILITY
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED
DENSITY ALTITUDE=5000 FT. GROSS WEIGHT= 6730 LB
CALIBRATED AIRSPEED = 95 KTS ROTOR SPEED = 324 RPM
CG LOCATION - 126.8 IN. (FWD)

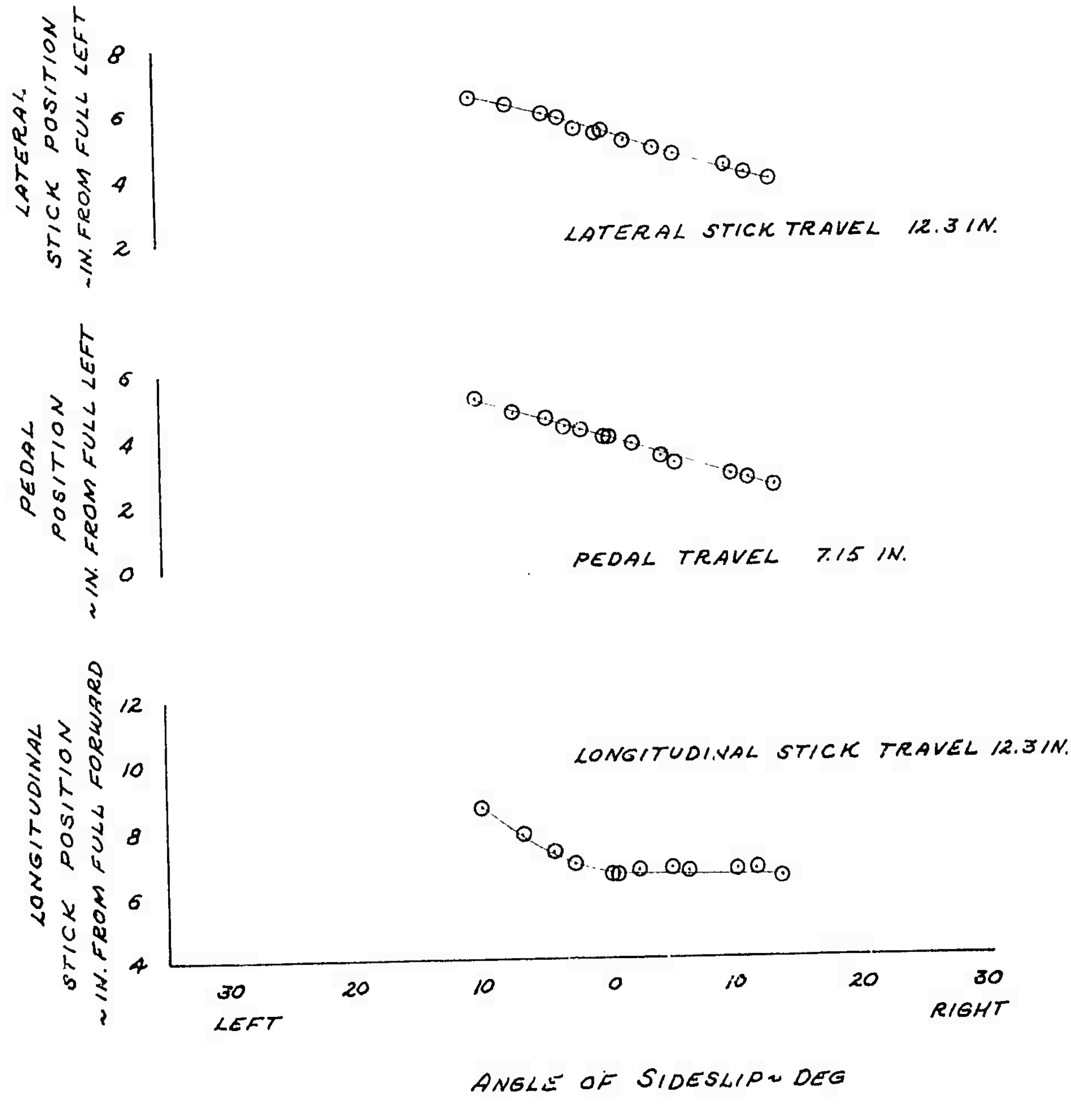


FIGURE NO. 25

RESPONSE TO AN AFT

UH-1B USA s/n 60-354

FULL CONTROL TRAVEL— 12.3 INCHES
C.G. LOCATION – STATION-126 IN (FWD)
AVERAGE GROSS WEIGHT-6600 LBS

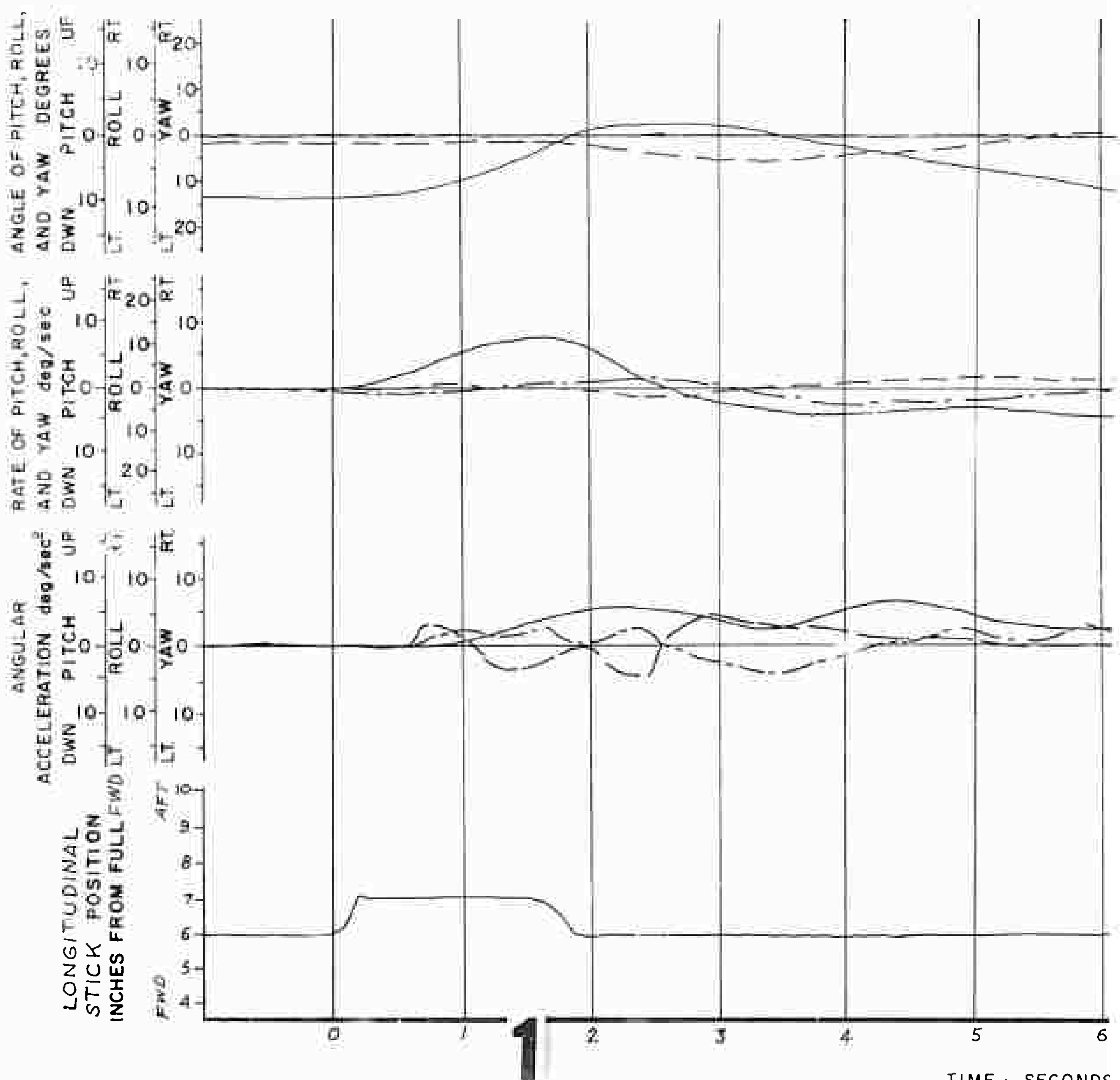


FIGURE NO. 25

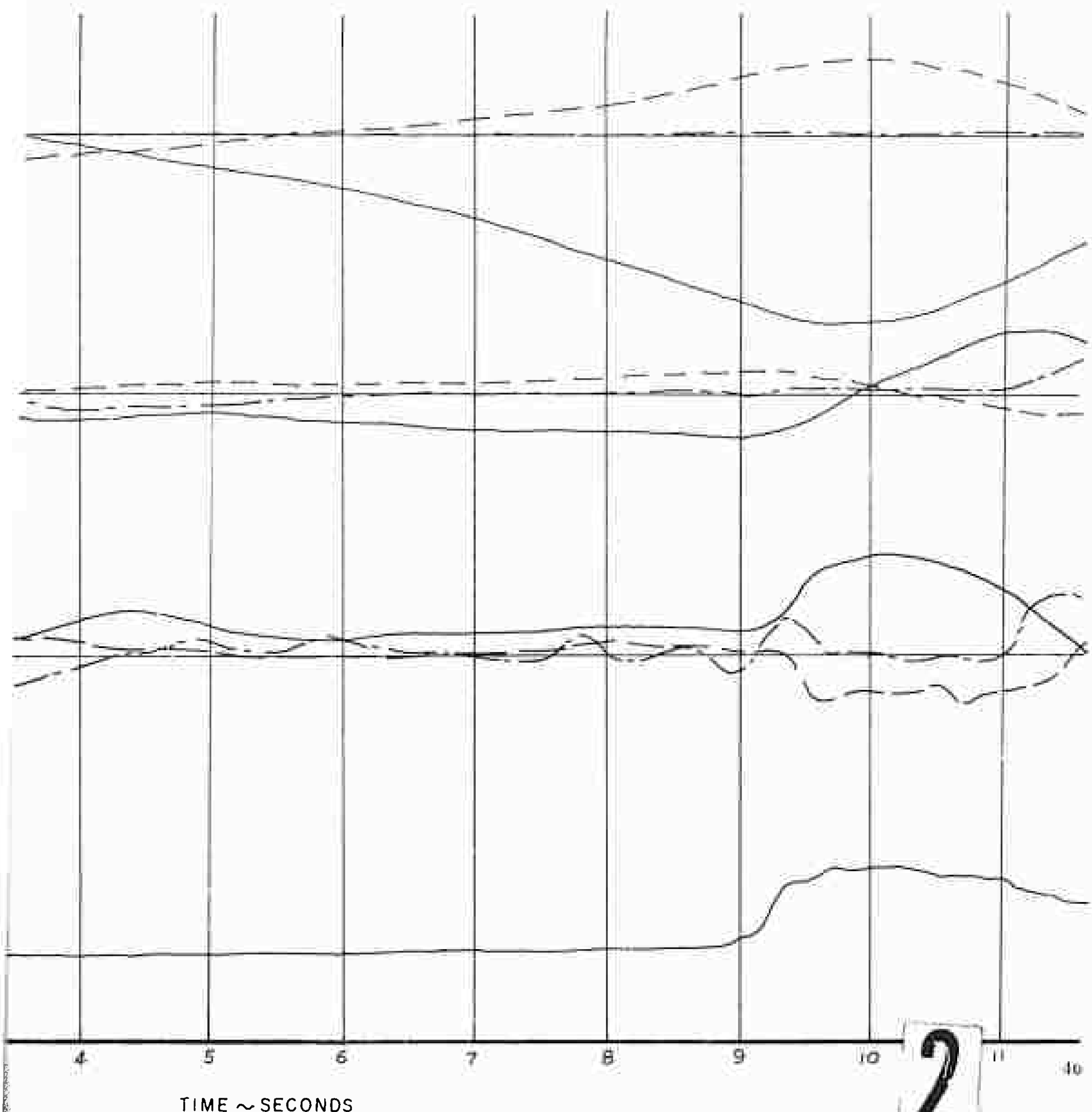
PONSE TO AN AFT LONGITUDINAL PULSE

·IB USA s/n 60-3548 FLOAT KIT INSTALLED

L TRAVEL– 12.3 INCHES
– STATION–126 IN (FWD)
;S WEIGHT–6600 LBS

TRIM CAS–95 KNOTS
DENSITY ALTITUDE–5000 FT.
ROTOR SPEED–324 RPM

PITCH ————
ROLL — — —
YAW —·—·—



2

FIGURE NO. 26
RESPONSE TO A FORWAR
UH-1B USA s/n 60-3548
FULL CONTROL TRAVEL— 12.3 INCHES
C.G. LOCATION - STATION- 126 IN.(FWD)
AVERAGE GROSS WEIGHT-6600 LBS

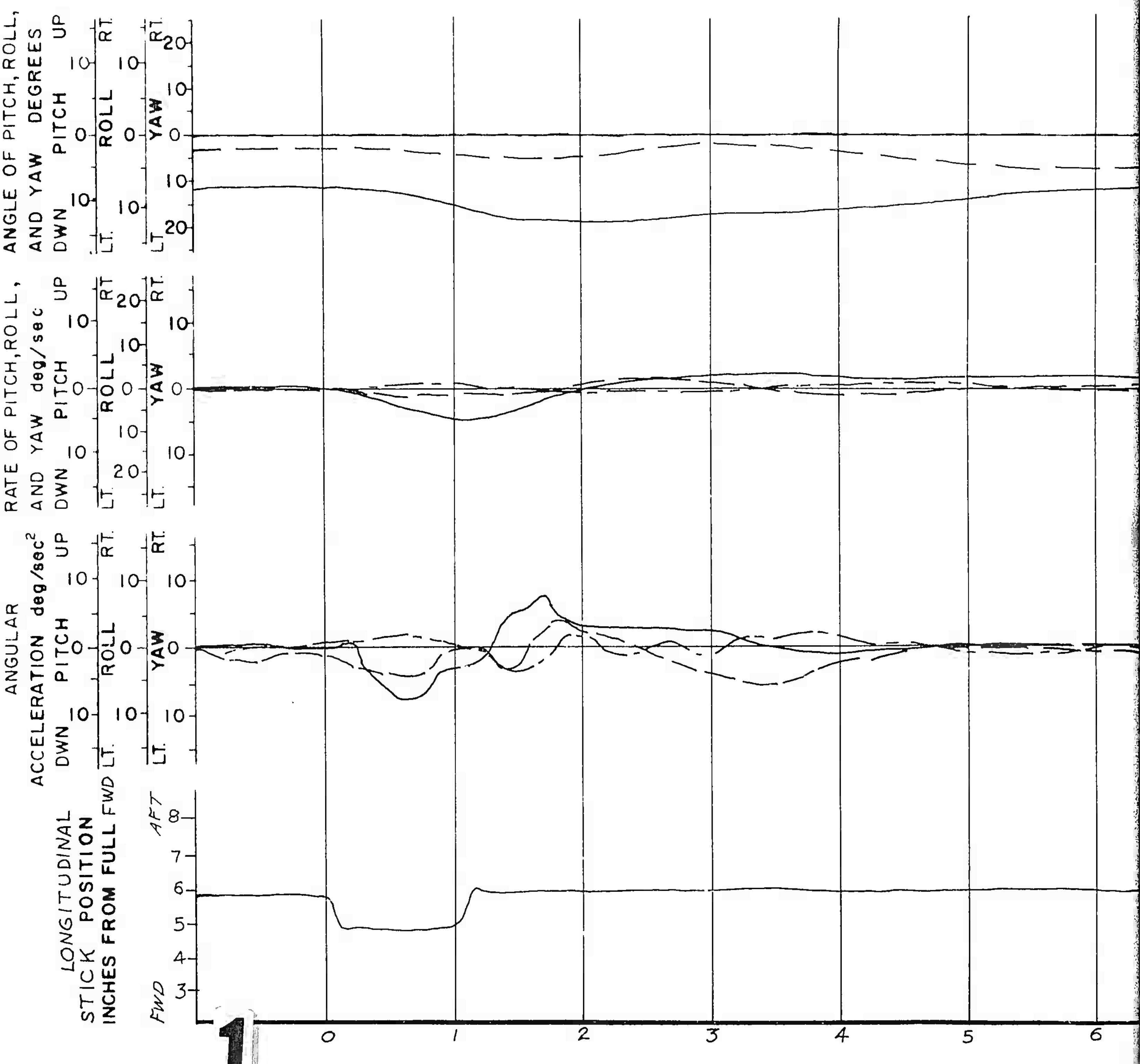


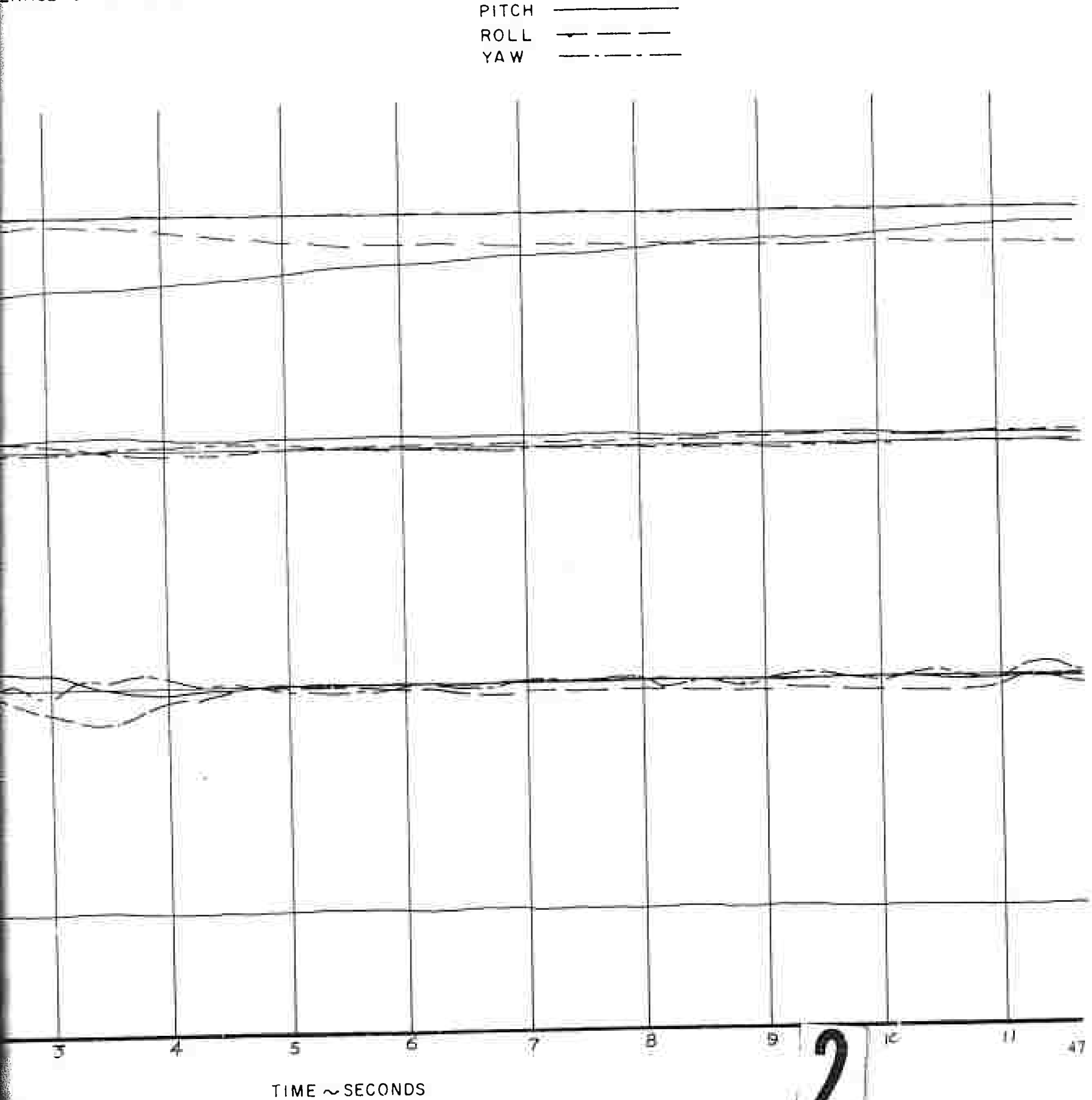
FIGURE NO. 26

RESPONSE TO A FORWARD LONGITUDINAL PULSE

UH-1B USA s/n 60-3548 FLOAT KIT INSTALLED

LL CONTROL TRAVEL— 12.3 INCHES
. LOCATION— STATION— 126 IN.(FWD)
ERAGE GROSS WEIGHT—6600 LBS

TRIM CAS— 95 KNOTS
DENSITY ALTITUDE—5000 FT.
ROTOR SPEED— 324 RPM



2

FIGURE NO. 27
RESPONSE TO A RIG
UH-1B USA s/n 60-3
FULL CONTROL TRAVEL – 12.3 INCHES
C.G. LOCATION – STATION – 126 IN (FWD)
AVERAGE GROSS WEIGHT – 6600 LBS

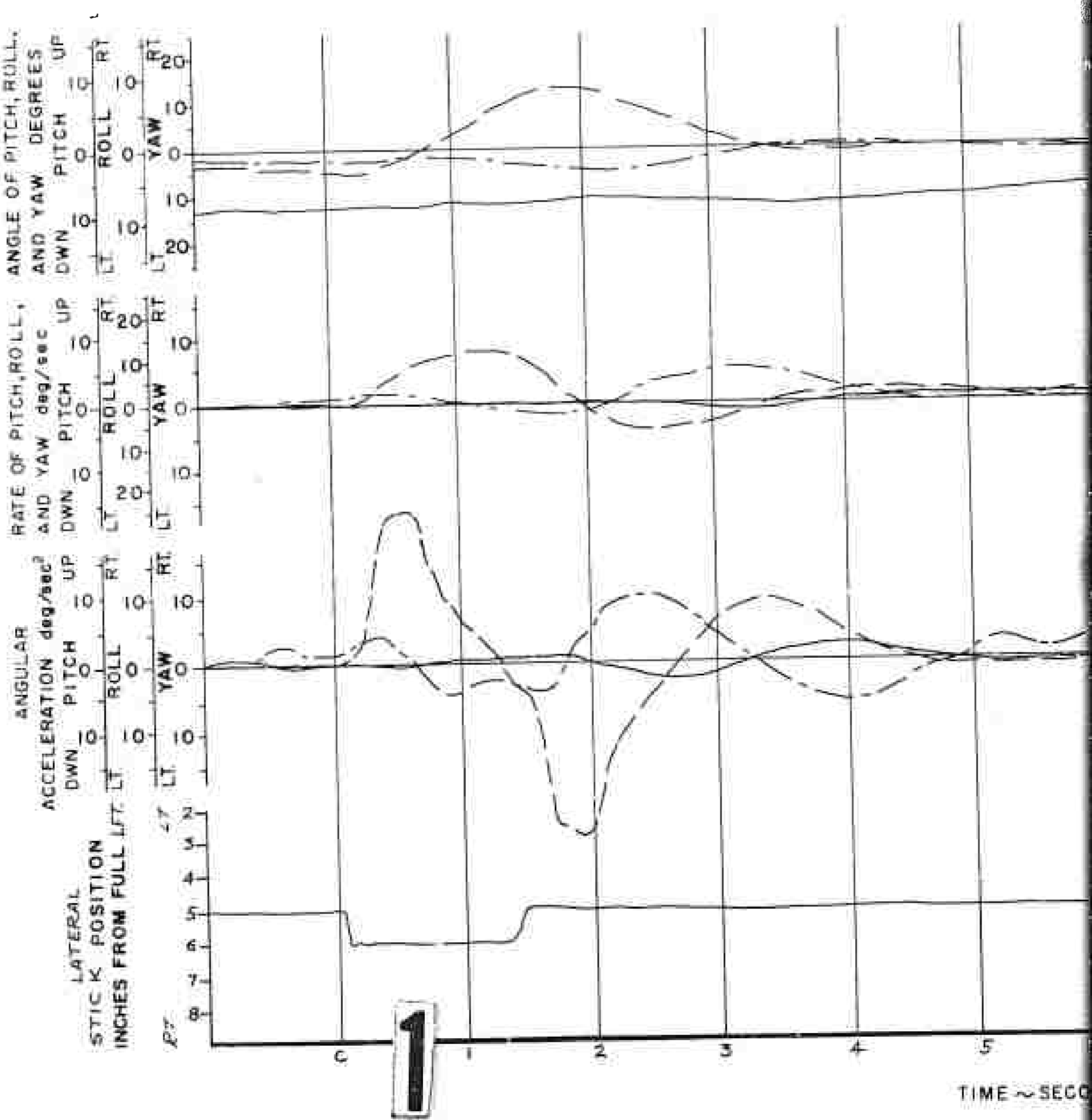


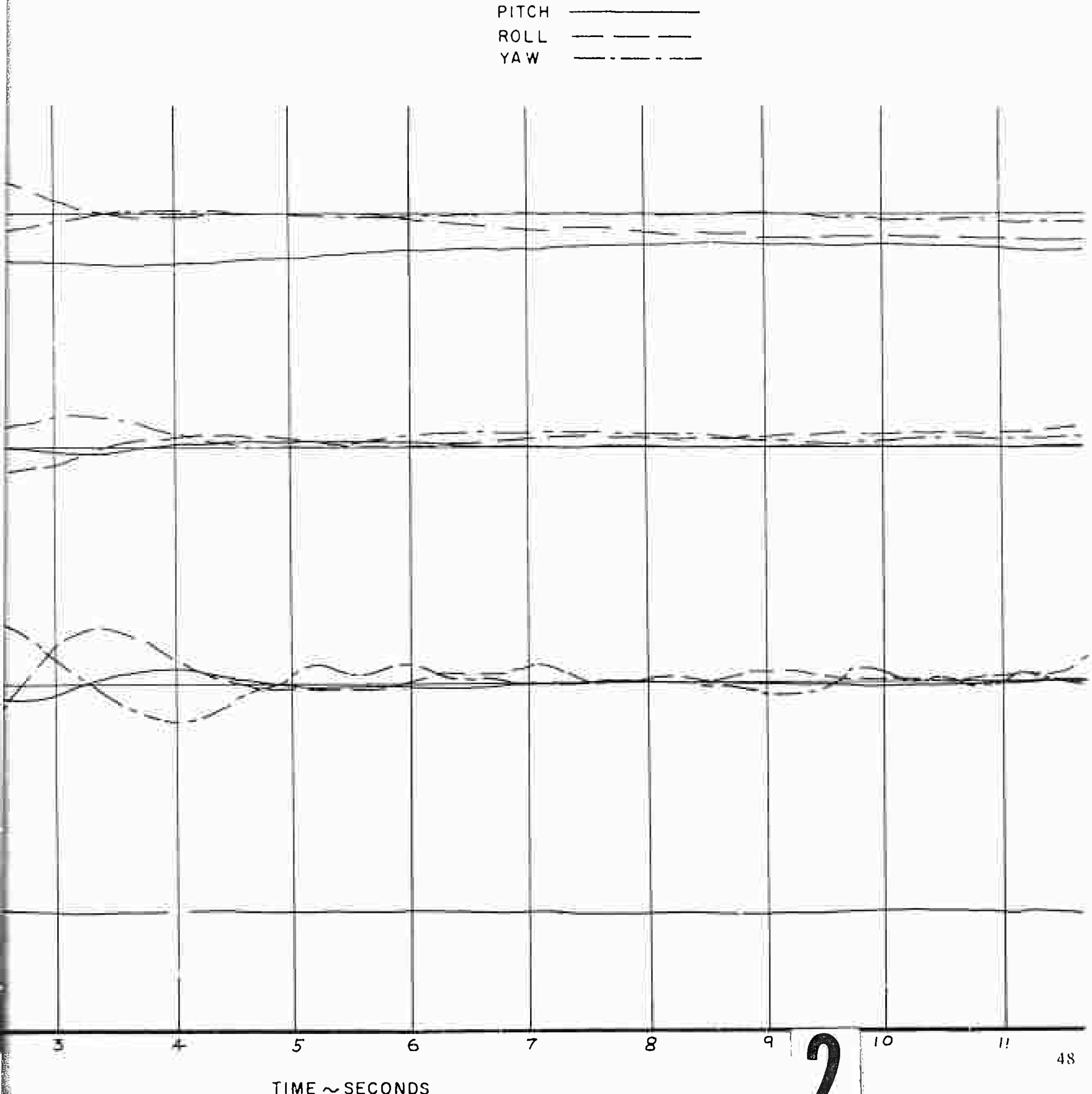
FIGURE NO. 27

RESPONSE TO A RIGHT LATERAL PULSE

UH-1B USA s/n 60-3548 FLOAT KIT INSTALLED

ULL CONTROL TRAVEL – 12.3 INCHES
C. LOCATION – STATION – 126 IN (FWD)
VERAGE GROSS WEIGHT – 6600 LBS

TRIM CAS – 95 KNOTS
DENSITY ALTITUDE – 5000 FT.
ROTOR SPEED – 324 RPM



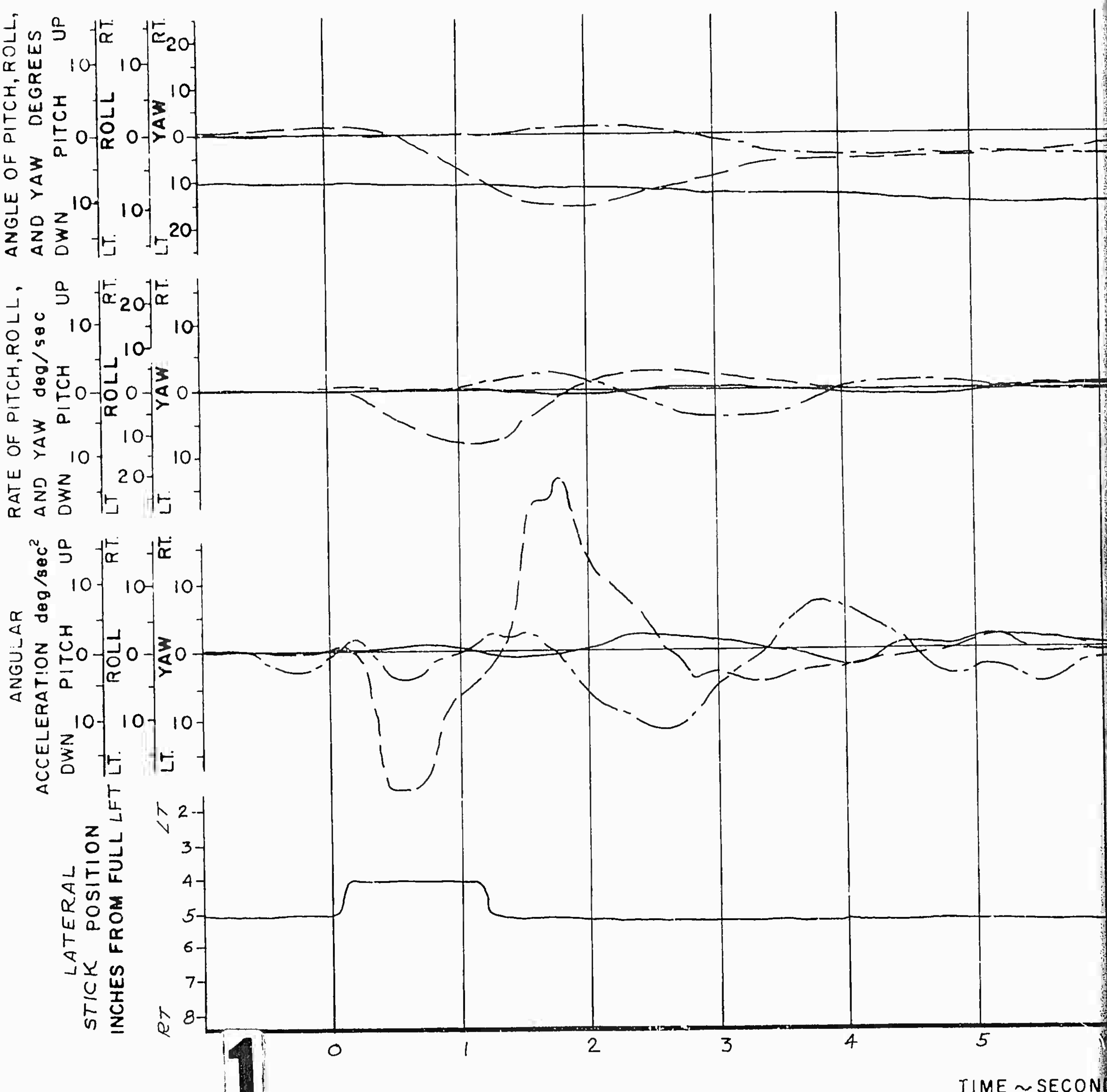
2

FIGURE NO. 26

RESPONSE TO A LEFT

UH-1B USA s/n 60-35

FULL CONTROL TRAVEL — 12.3 INCHES
C.G. LOCATION - STATION - 126 IN (FWD)
AVERAGE GROSS WEIGHT - 6600 LBS



1

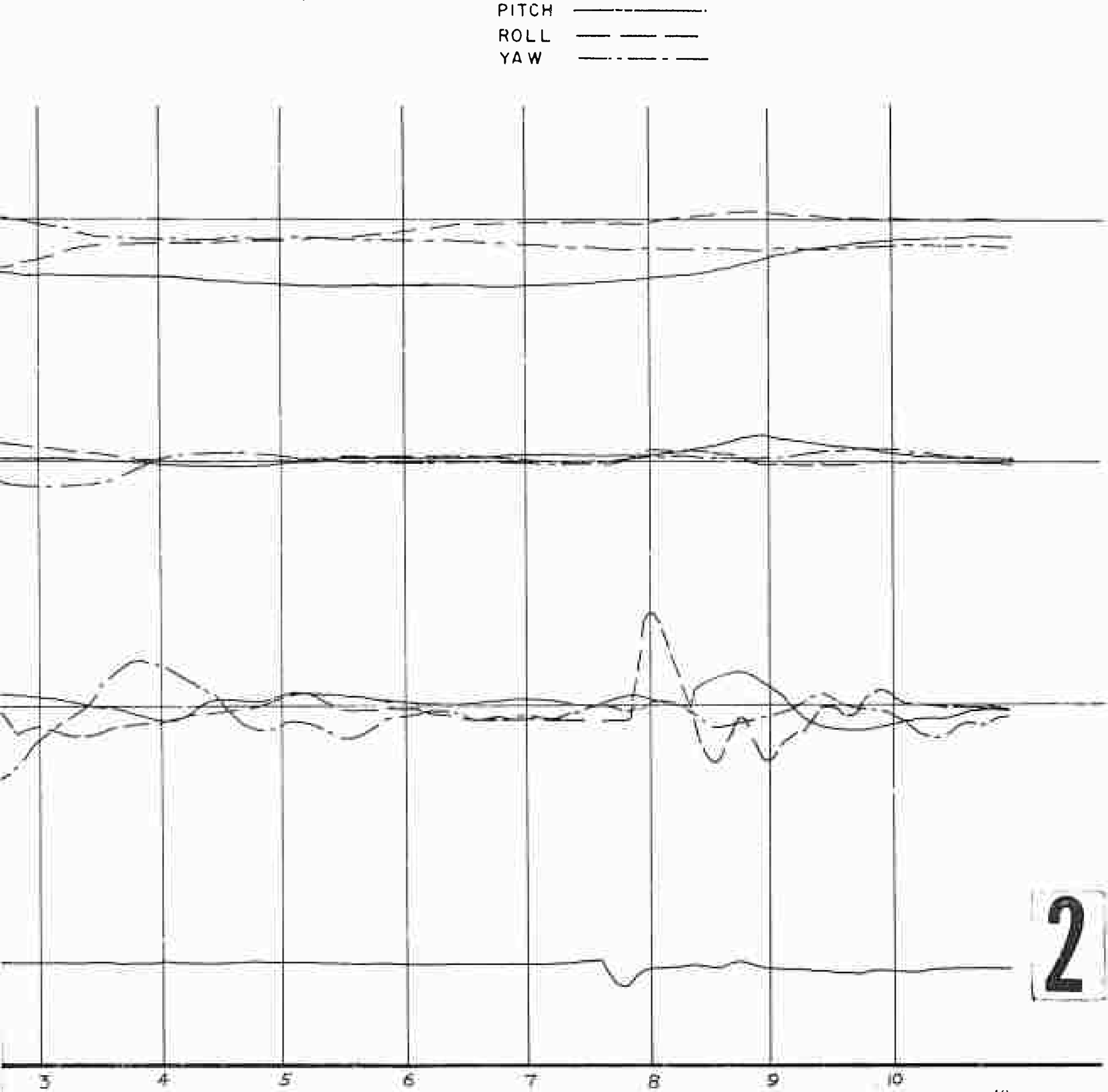
FIGURE NO. 28

RESPONSE TO A LEFT LATERAL PULSE

UH-1B USA s/n 60-3548 FLOAT KIT INSTALLED

LL CONTROL TRAVEL — 12.3 INCHES
. LOCATION — STATION — 126 IN (FWD)
ERAGE GROSS WEIGHT — 6600 LBS

TRIM CAS — 95 KNOTS
DENSITY ALTITUDE — 5000 FT.
ROTOR SPEED — 324 RPM



TIME ~ SECONDS

2

FIGURE NO. 29

RESPONSE TO A RIGHT

UH-1B USA s/n 60-3545

FULL PEDAL TRAVEL—7.15 INCHES
C.G. LOCATION—STATION—126 IN (FWD)
AVERAGE GROSS WEIGHT—6600 LBS

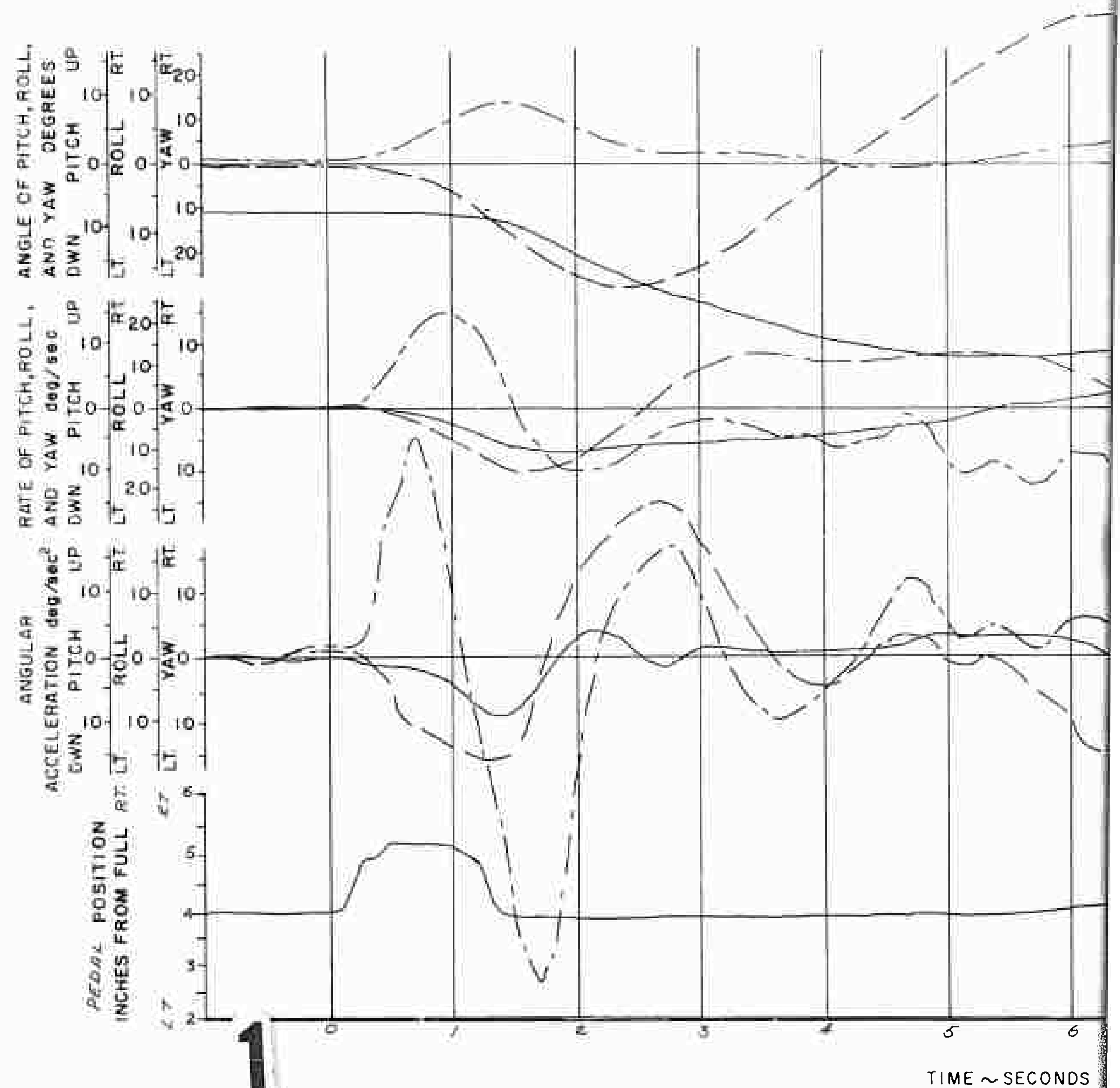
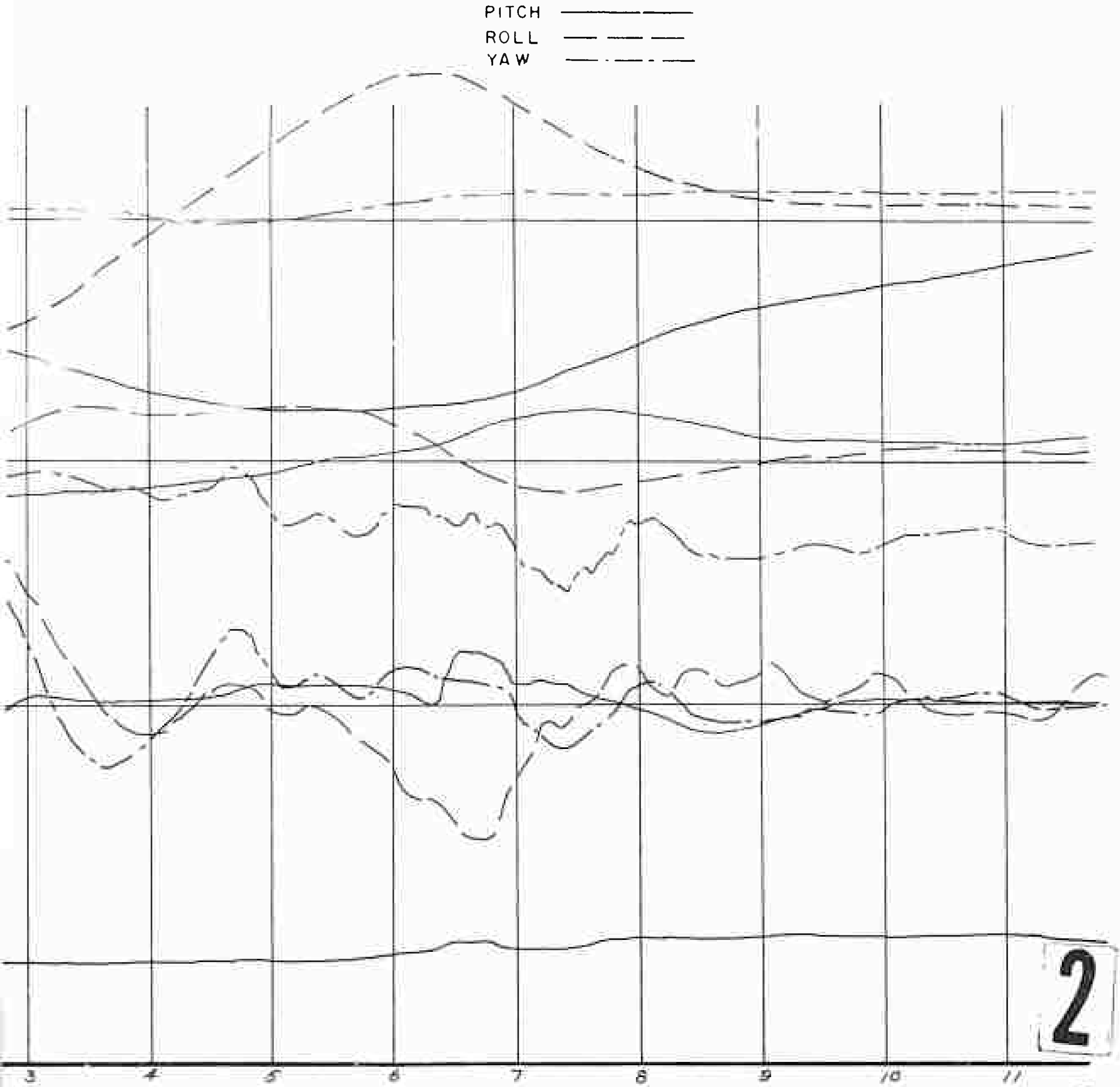


FIGURE NO. 29
RESPONSE TO A RIGHT DIRECTIONAL PULSE
UH-1B USA s/n 60-3548 FLOAT KIT INSTALLED

. PEDAL TRAVEL – 7.15 INCHES
LOCATION – STATION – 126 IN (FWD)
AGE GROSS WEIGHT – 6600 LBS

TRIM CAS – 95 KNOTS
DENSITY ALTITUDE – 5000 FT.
ROTOR SPEED – 324 RPM



TIME ~ SECONDS

FIGURE NO. 3

RESPONSE TO A LE

UH-1B USA s/n 60-3

FULL PEDAL TRAVEL— 7.15 INCHES
C.G. LOCATION – STATION-126 IN (FWD)
AVERAGE GROSS WEIGHT-6600 LBS

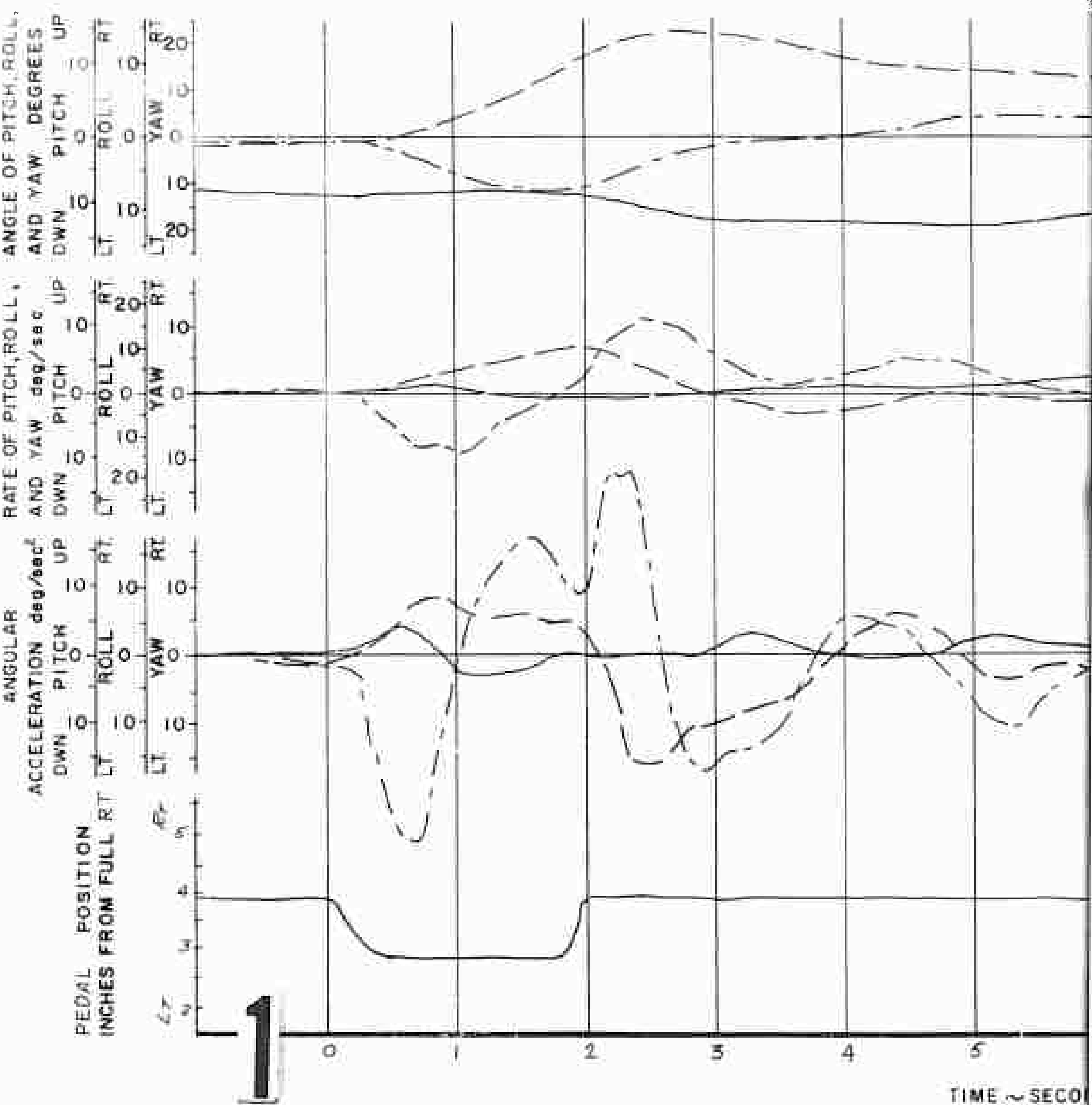


FIGURE NO. 30

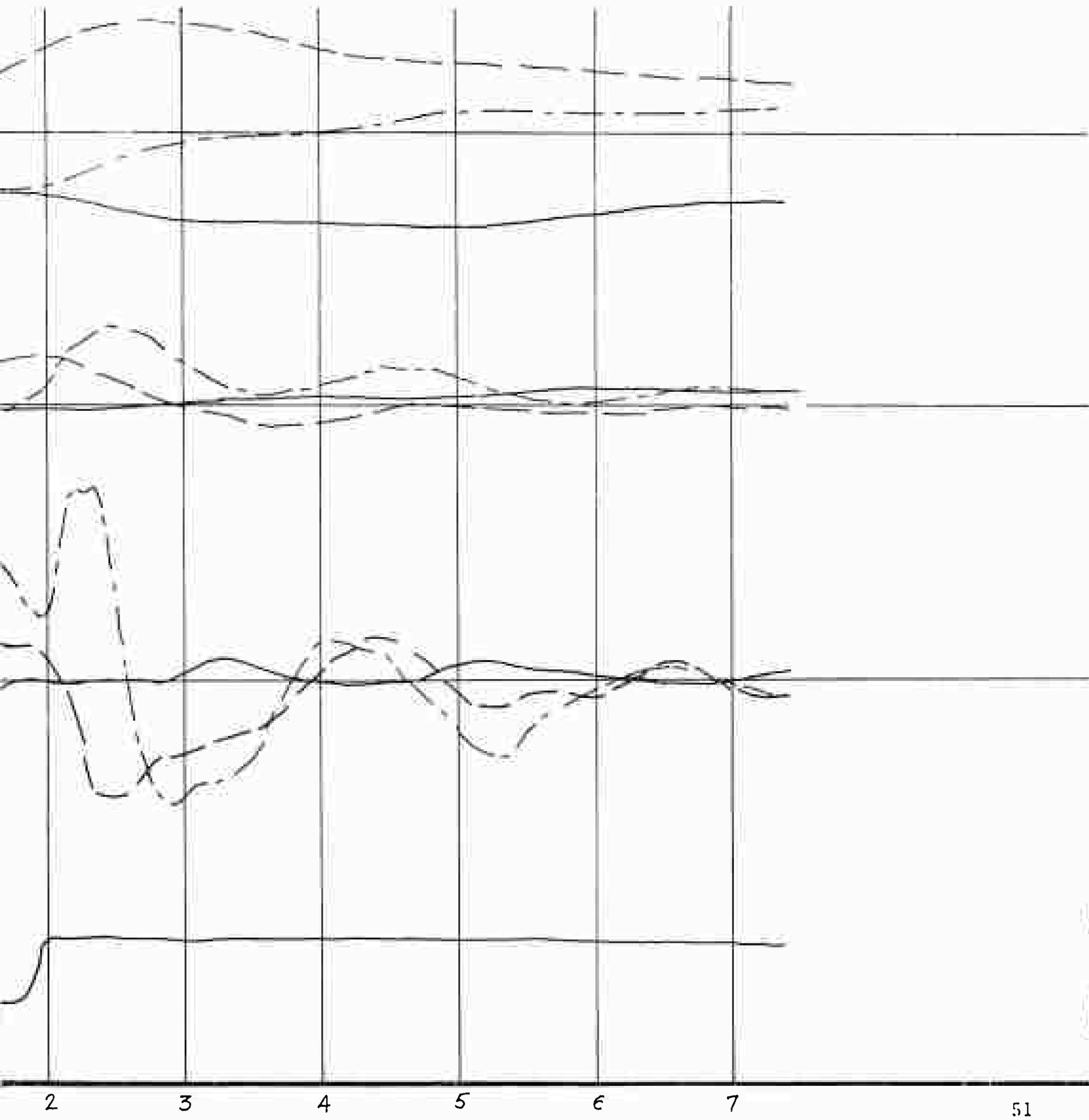
RESPONSE TO A LEFT DIRECTIONAL PULSE

UH-1B USA s/n 60-3548 FLOAT KIT INSTALLED

FULL PEDAL TRAVEL – 7.15 INCHES
C.G. LOCATION – STATION-126 IN (FWD)
AVERAGE GROSS WEIGHT-6600 LBS

TRIM CAS-95 KNOTS
DENSITY ALTITUDE-5000 FT.
ROTOR SPEED-324 RPM

PITCH ————
ROLL — — —
YAW —·—·—



2

FIGURE NO. 31

RESPONSE TO AN AFT

UH-IB USA s/n 60-35

FULL CONTROL TRAVEL -12.3 INCHES

C.G. LOCATION - STATION 132.3 (AFT)

GROSS WT 6750 LB

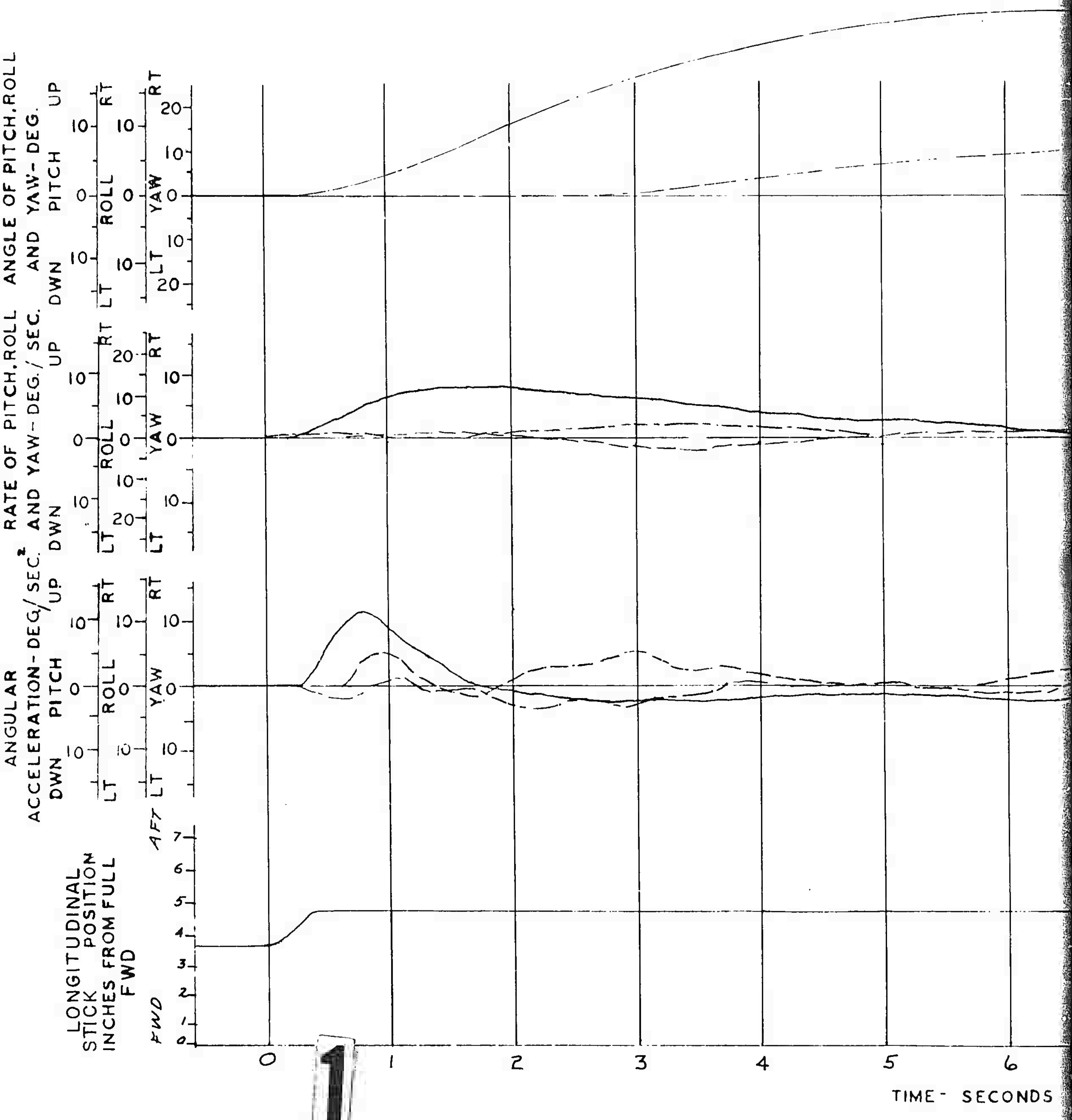


FIGURE NO. 31

RESPONSE TO AN AFT LONGITUDINAL STEP

UH-1B USA s/n 60-3548 FLOAT KIT INSTALLED

L CONTROL TRAVEL -12.3 INCHES
. LOCATION — STATION 132.3 (AFT)
OSS WT 6750 LB

TRIM CAS - 95 KNOTS
DENSITY ALTITUDE 4900 FT.
ROTOR SPEED 324 RPM

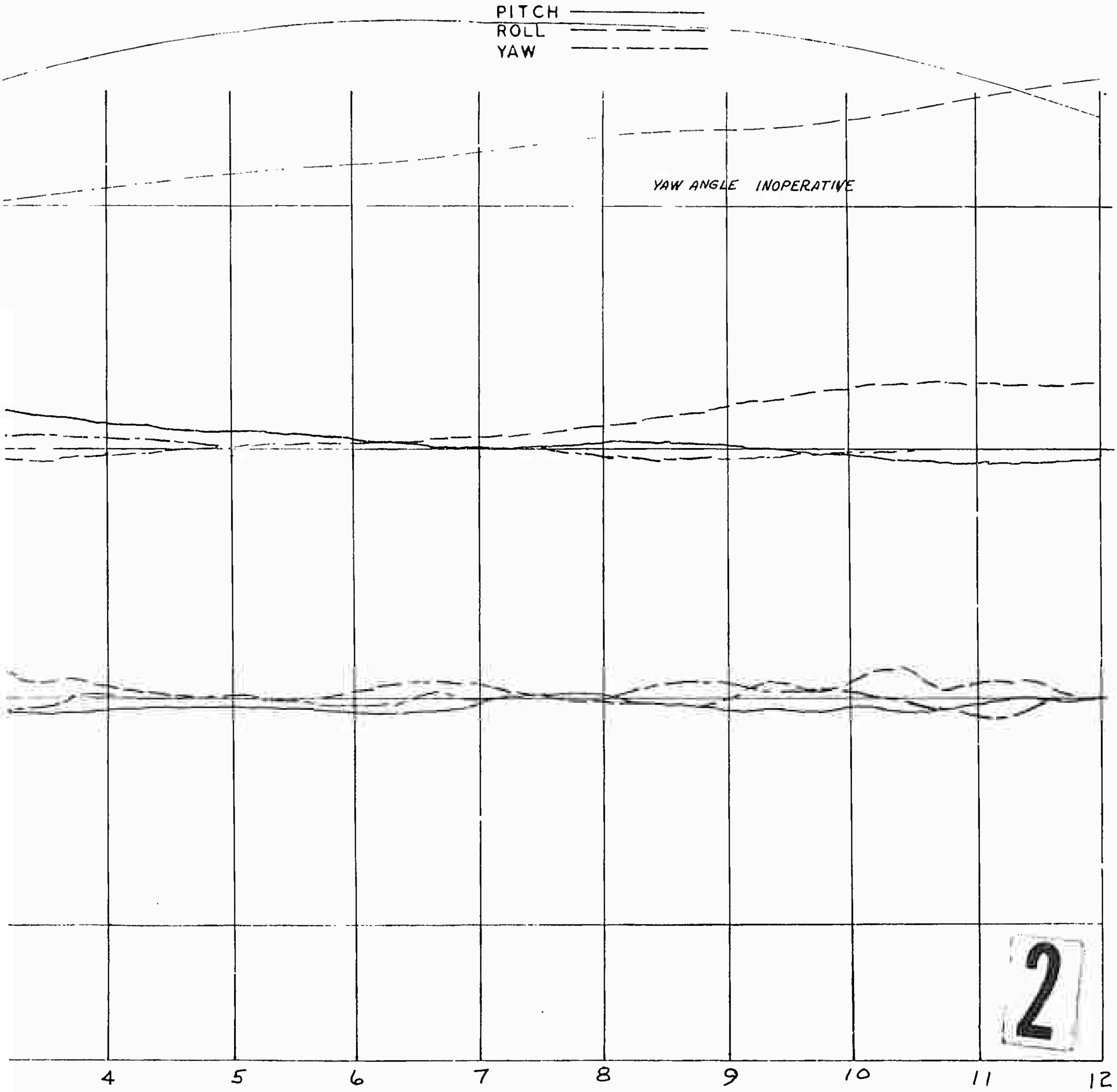


FIGURE NO. 32

RESPONSE TO A FWD LO

UH-1B USA s/n 60-354

FULL CONTROL TRAVEL -12.3 INCHES

C.G. LOCATION - STATION 132.3 (AFT)

GROSS WT. 6640 LB

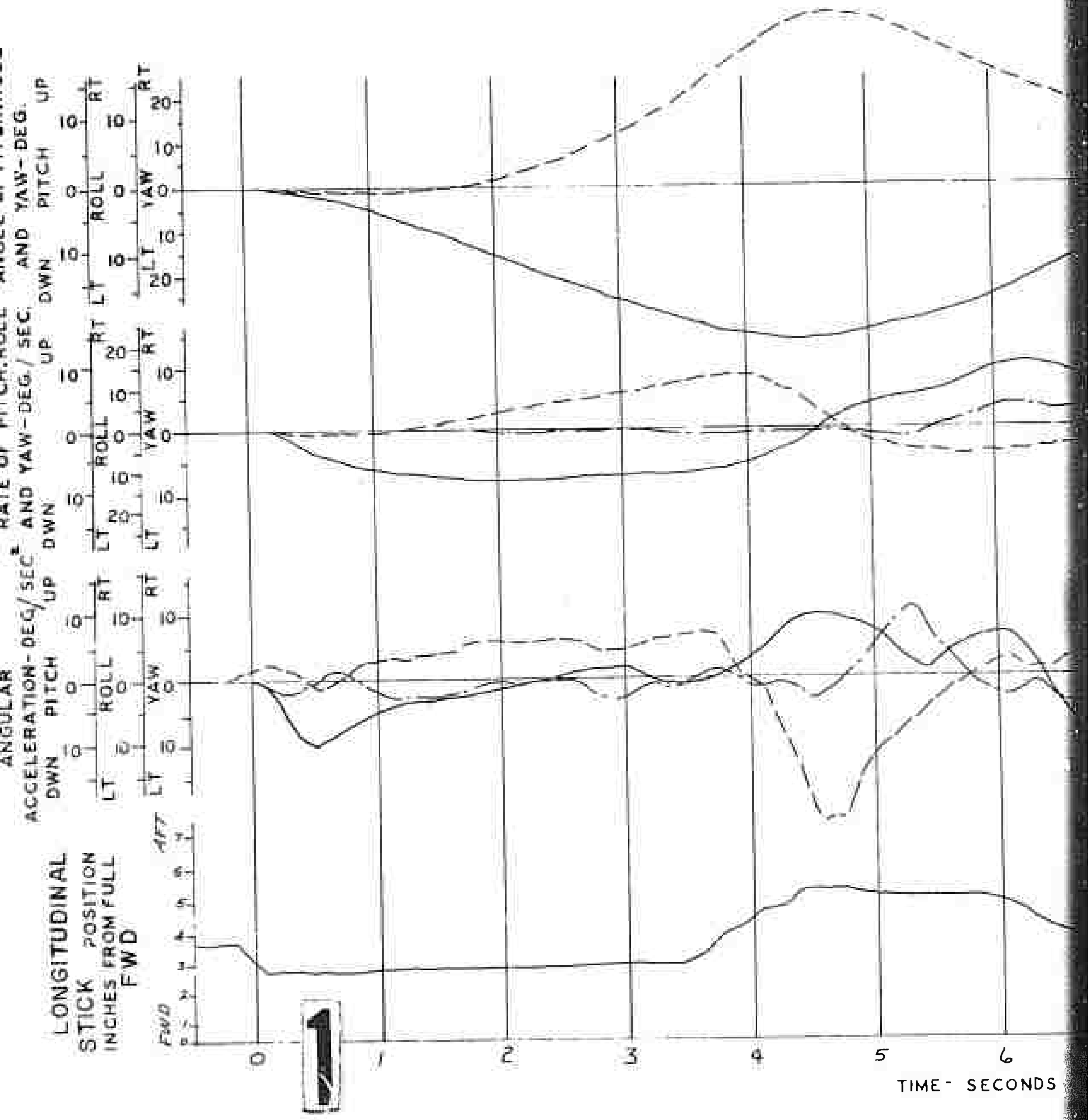


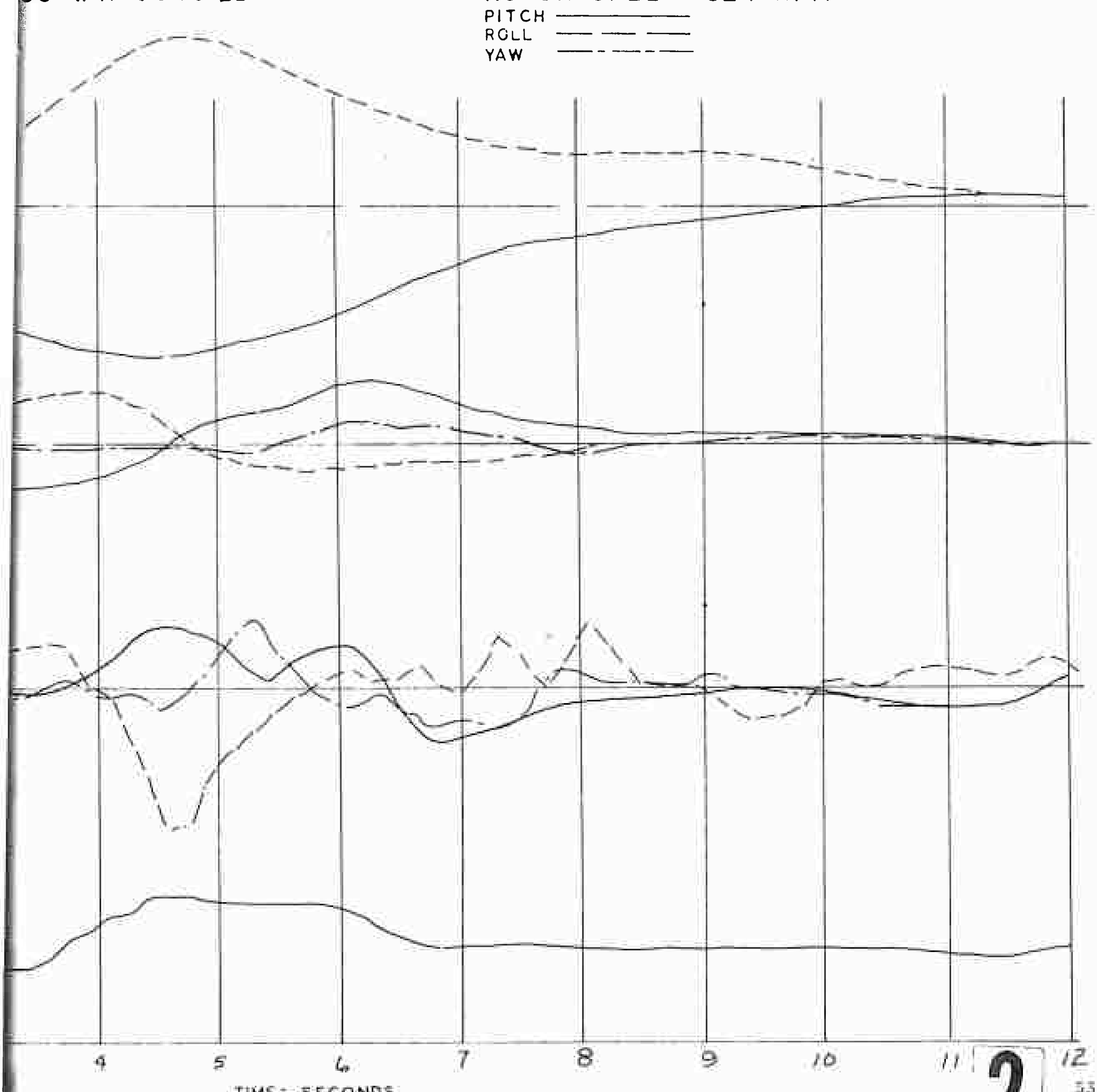
FIGURE NO. 32

RESPONSE TO A FWD LONGITUDINAL STEP

UH-1B USA s/n 60-3548 FLOAT KIT INSTALLED

CONTROL TRAVEL - 12.3 INCHES
OCATION - STATION 132.3 (AFT)
SS WT. 6640 LB

TRIM CAS - 95 KNOTS
DENSITY ALTITUDE 4900 FT.
ROTOR SPEED 324 RPM



2

FIGURE NO. 33

RESPONSE TO A RIGHT L

UH-1B USA s/n 60-354

FULL CONTROL TRAVEL - 12.3 INCHES

C.G. LOCATION - STATION 133.5 (AFT)

AVERAGE GROSS WEIGHT 6600 LBS.

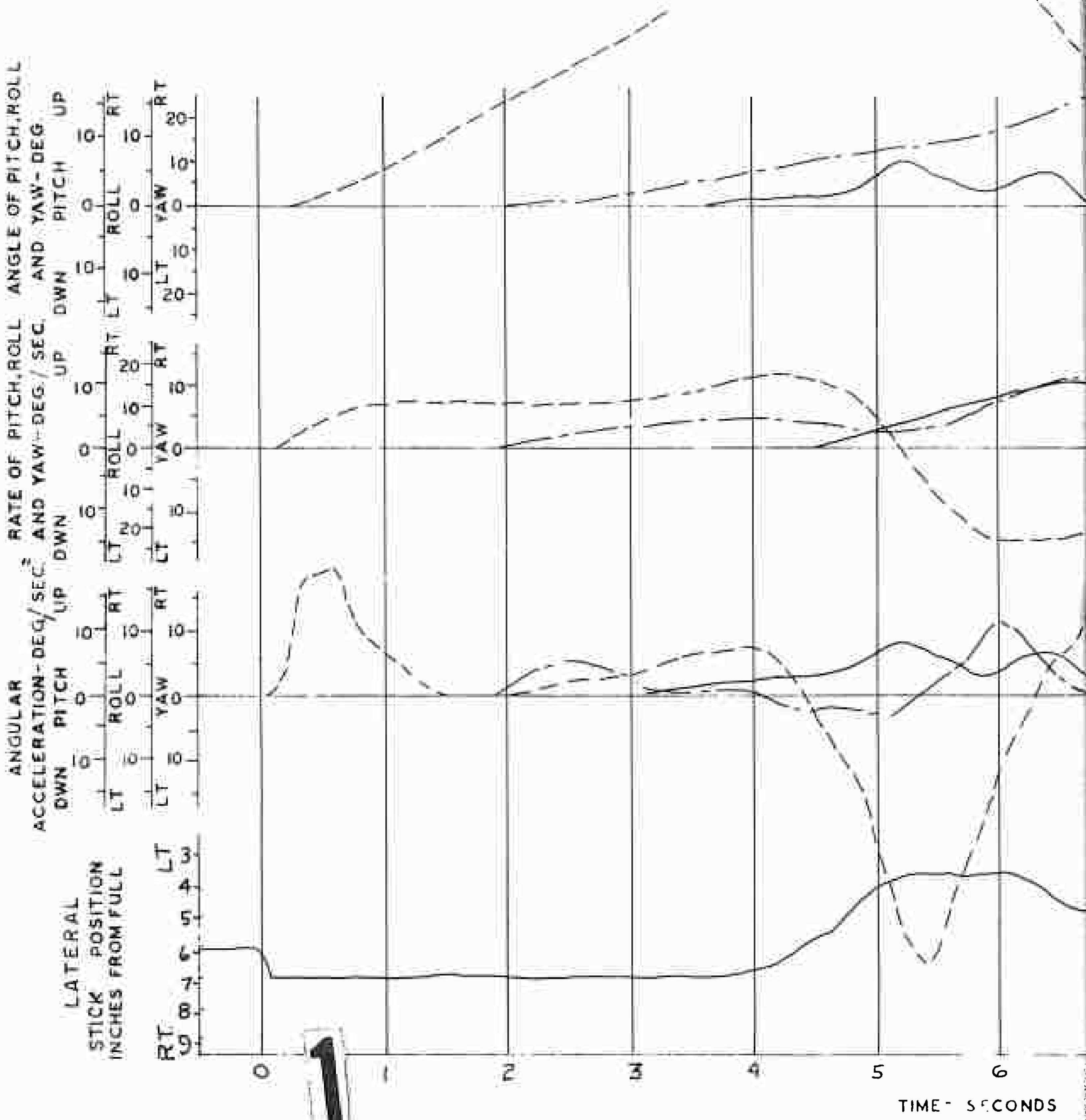


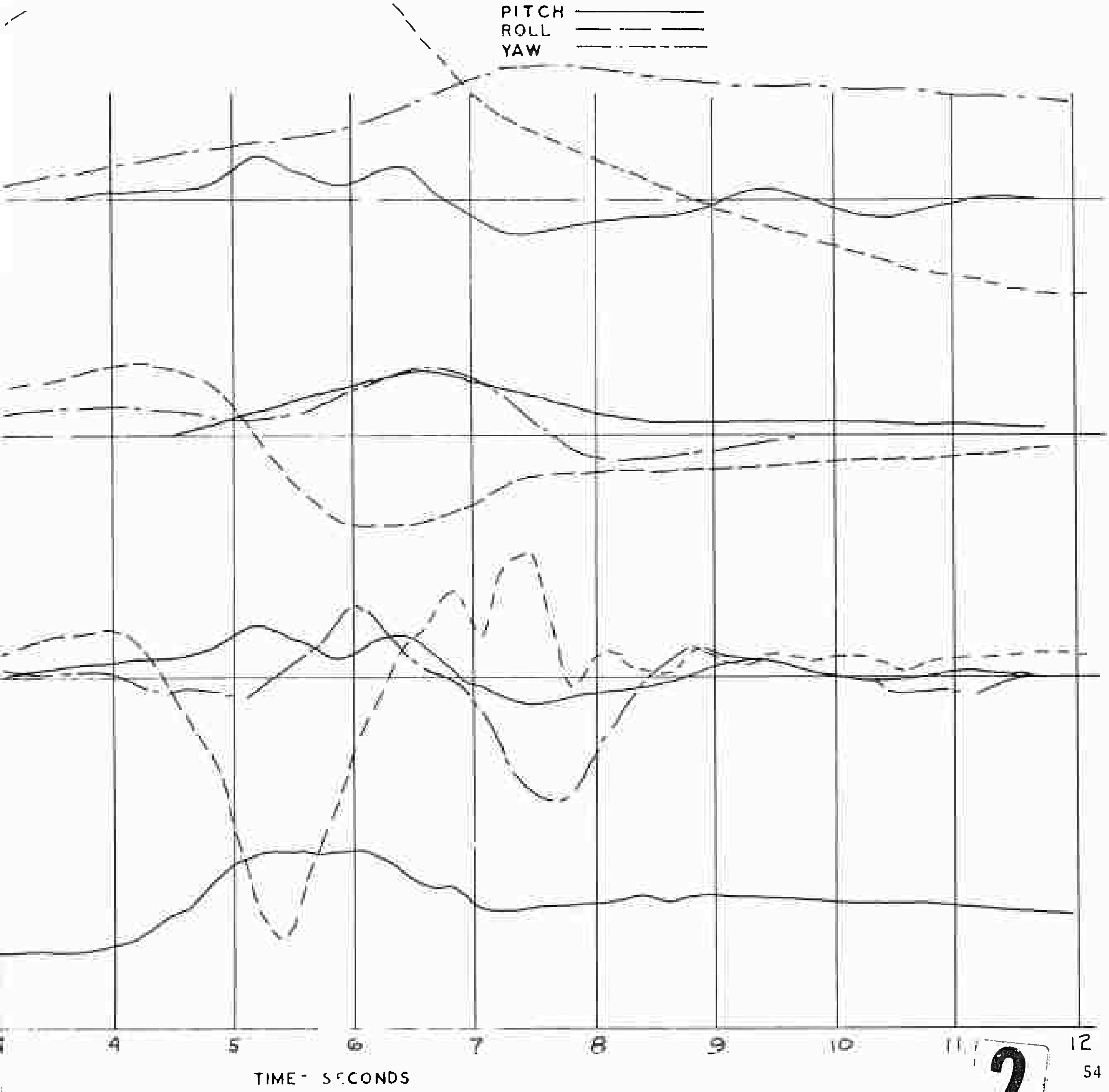
FIGURE NO. 33

RESPONSE TO A RIGHT LATERAL STEP

UH-1B USA s/n 60-3548 FLOAT KIT INSTALLED

ILL CONTROL TRAVEL - 12.3 INCHES
G. LOCATION - STATION 133.5 (AFT)
VERAGE GROSS WEIGHT 6600 LBS.

TRIM CAS - 95 KNOTS
DENSITY ALTITUDE 5000 FT.
ROTOR SPEED 324 RPM



2

FIGURE NO. 34

RESPONSE TO A LEFT L

UH-1B USA s/n 60-354

FULL CONTROL TRAVEL - 12.3 INCHES

C.G. LOCATION - STATION 133.5 (AFT)

AVERAGE GROSS WEIGHT 6600 LBS.

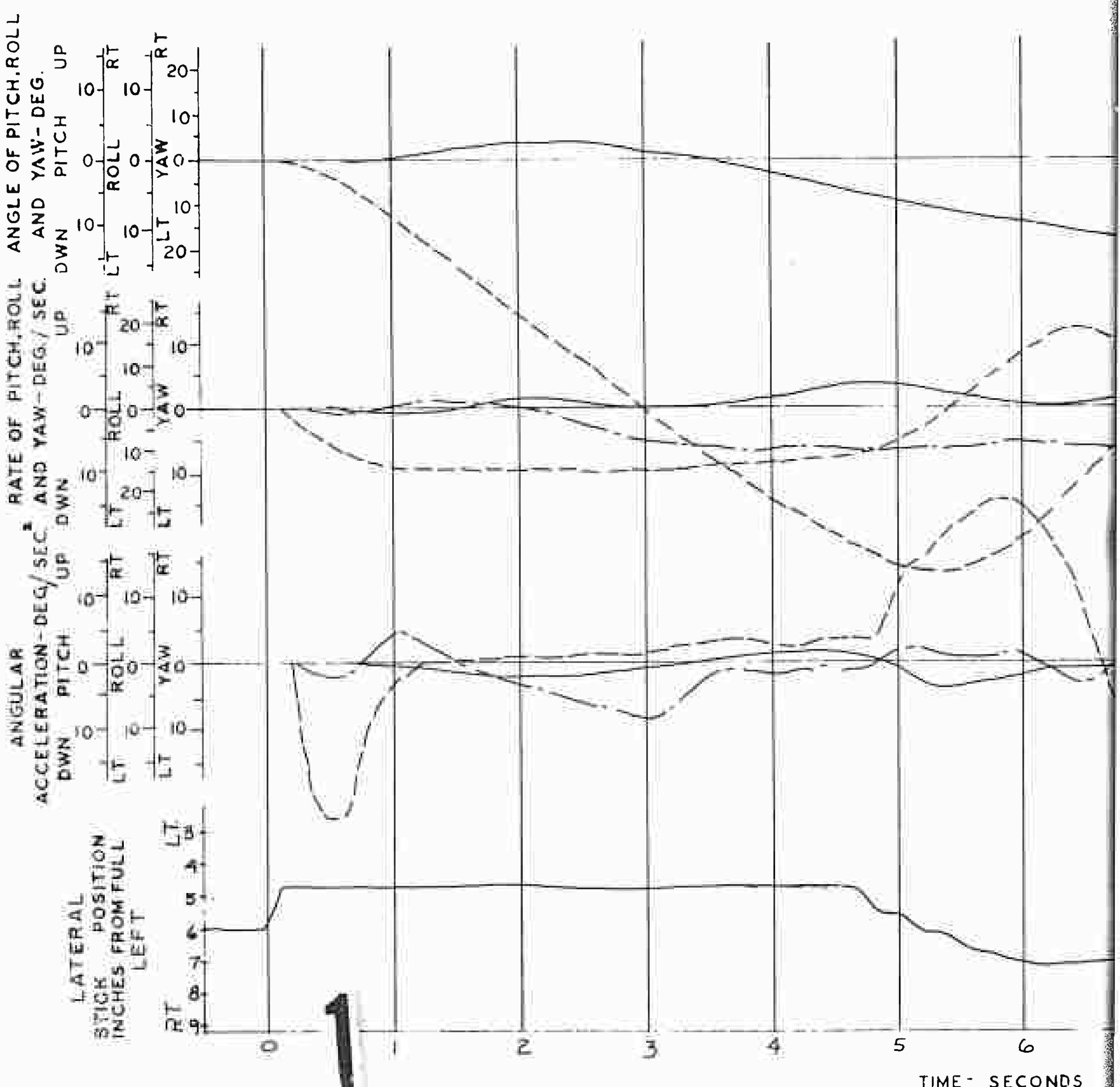


FIGURE NO. 34

RESPONSE TO A LEFT LATERAL STEP

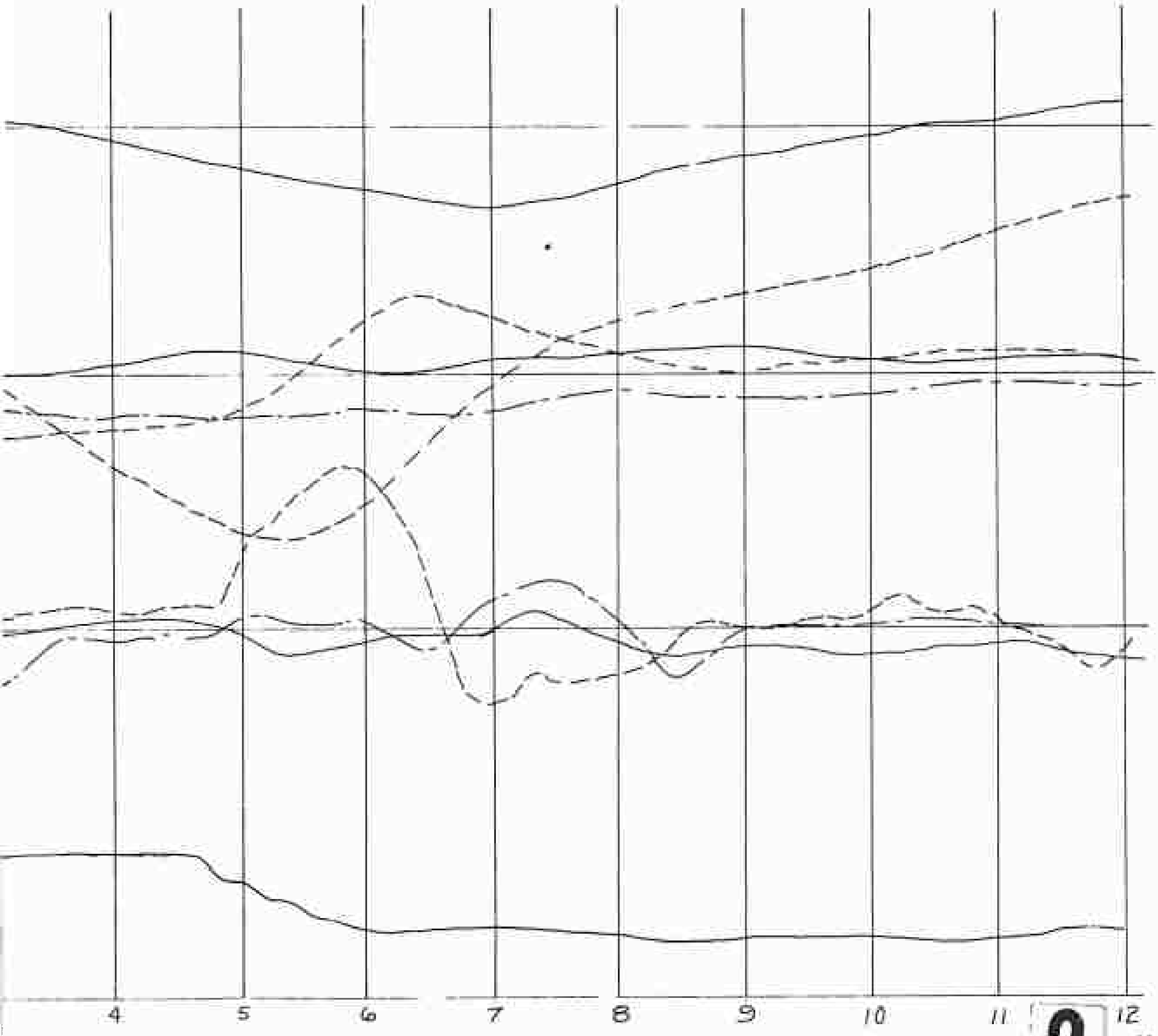
UH-1B USA s/n 60-3548 FLOAT KIT INSTALLED

LL CONTROL TRAVEL - 12.3 INCHES
TRIM CAS - 95 KNOTS

G. LOCATION - STATION 133.5 (AFT)
DENSITY ALTITUDE 5000 FT.

VERAGE GROSS WEIGHT 6600 LBS.
ROTOR SPEED 324 RPM

PITCH ———
ROLL — — —
YAW —·—·—



2

55

FIGURE NO. 35

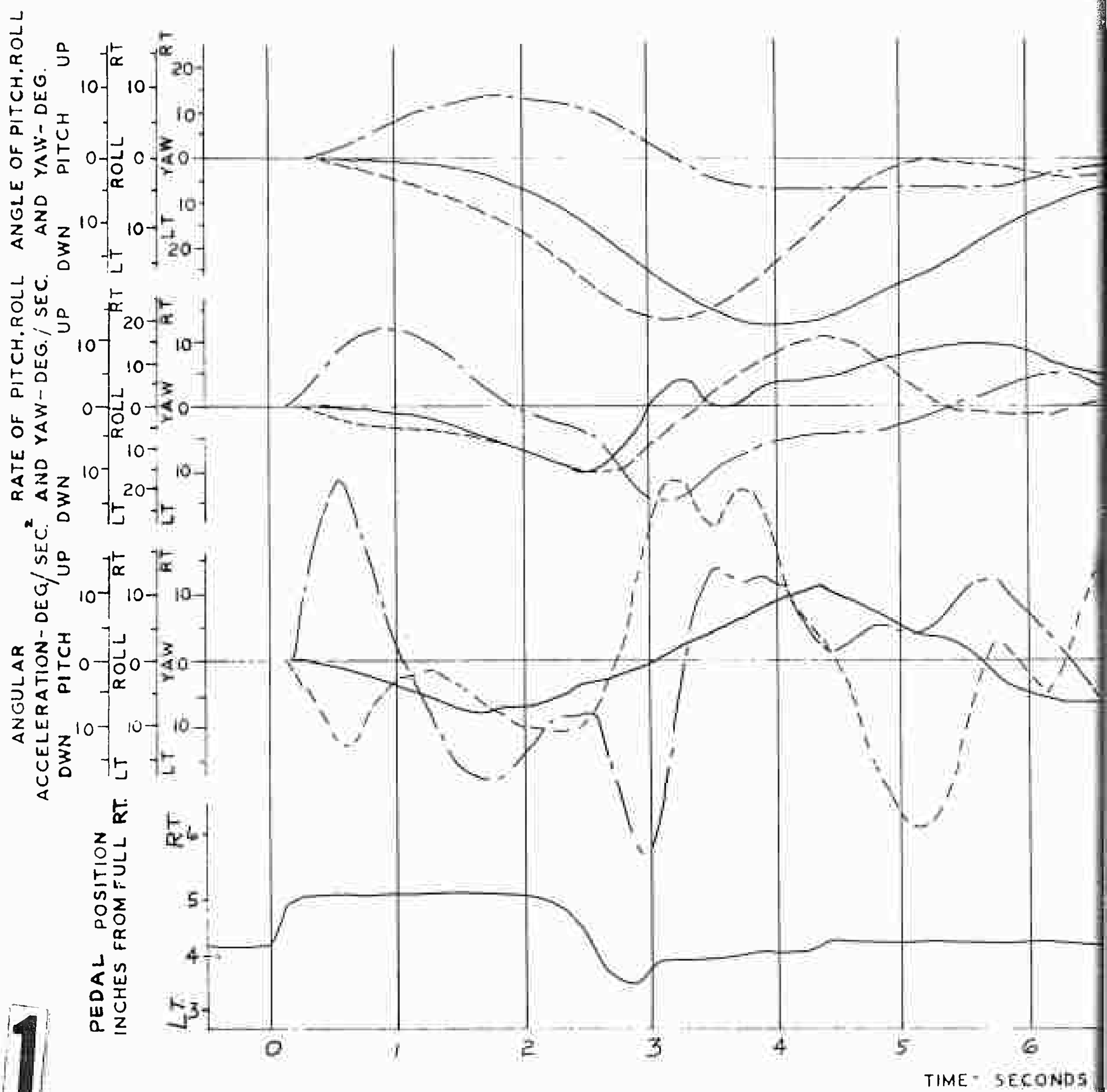
RESPONSE TO A RIGHT

UH-1B USA s/n 60-35

FULL PEDAL TRAVEL - 7.15 INCHES

C.G. LOCATION - STATION 133.5 (AFT)

GROSS WT 6600 LBS.



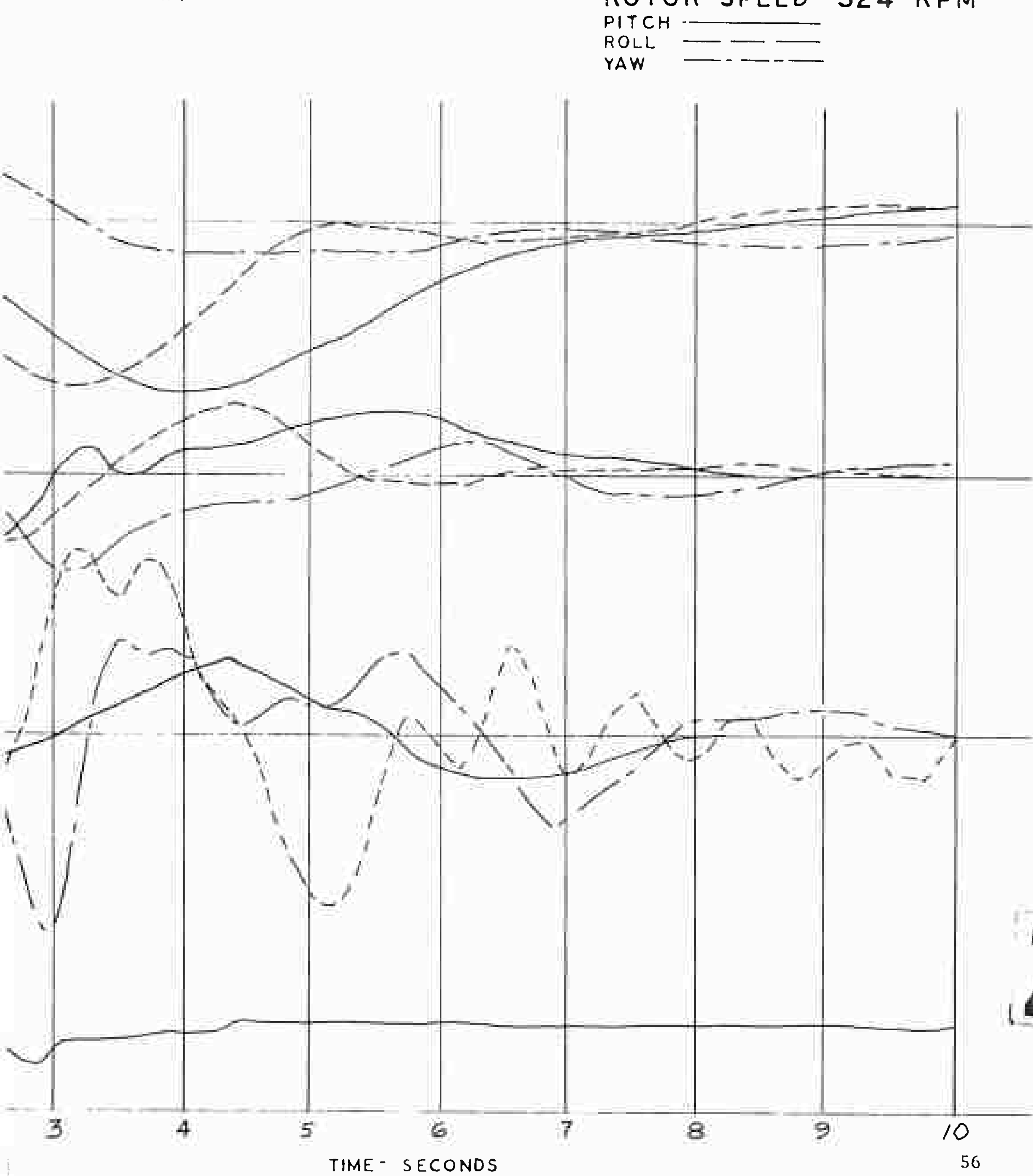
1

FIGURE NO. 35

RESPONSE TO A RIGHT DIRECTIONAL STEP
UH-1B USA s/n 60-3548 FLOAT KIT INSTALLED

FULL PEDAL TRAVEL - 7.15 INCHES
C.G. LOCATION - STATION 133.5 (AFT)
GROSS WT 6600 LBS.

TRIM CAS - 95 KNOTS
DENSITY ALTITUDE 5000 FT.
ROTOR SPEED 324 RPM



2

FIGURE NO. 36

CONTROL POSITIONS IN SIDEWARD FLIGHT

UH-1B USA S/N 60-3548

FLOAT KIT INSTALLED

DENSITY ALTITUDE = 2150 FT. GROSS WEIGHT = 7530 LB.

ROTOR SPEED = 324 RPM CG LOCATION - 126.3 (FWD)

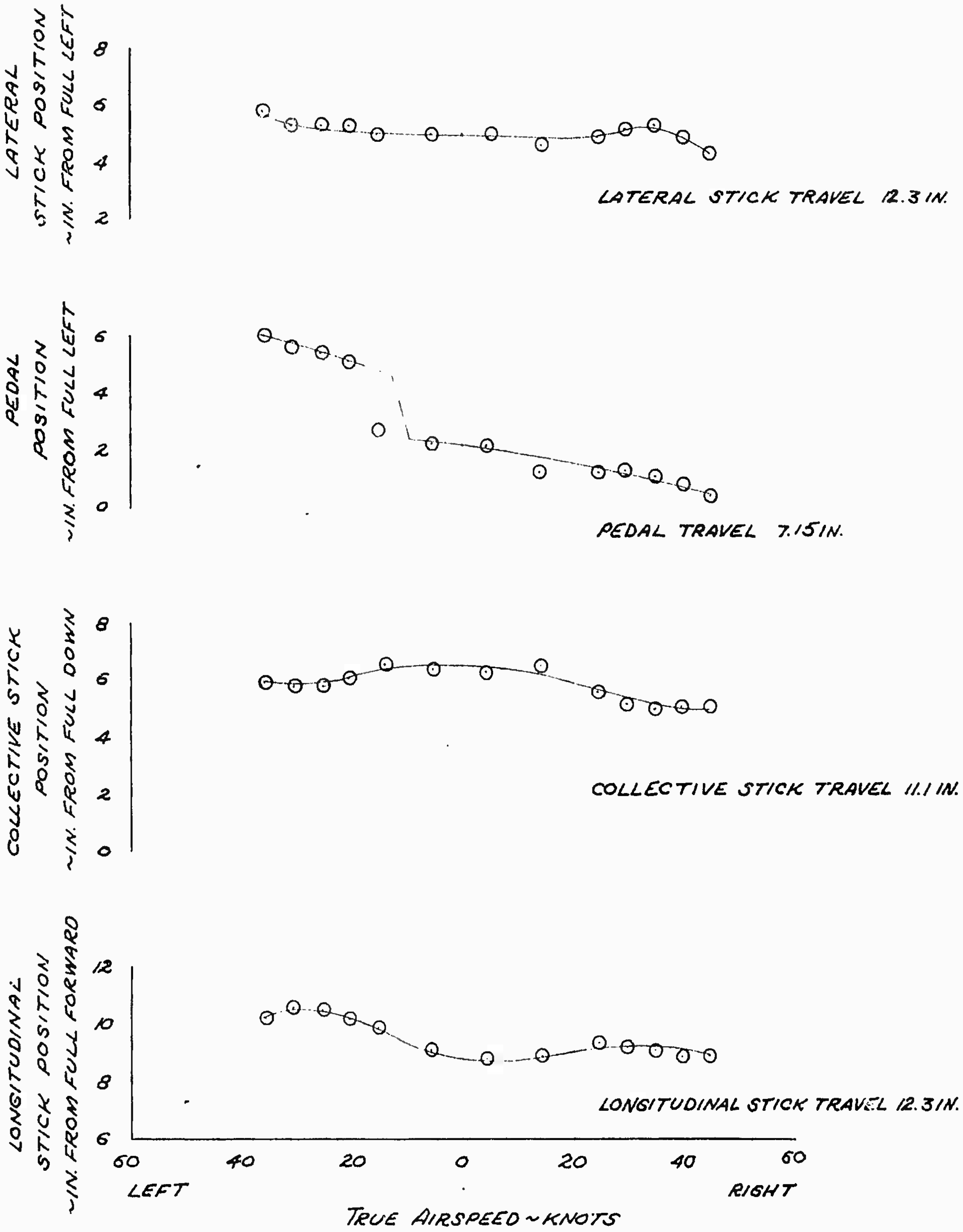
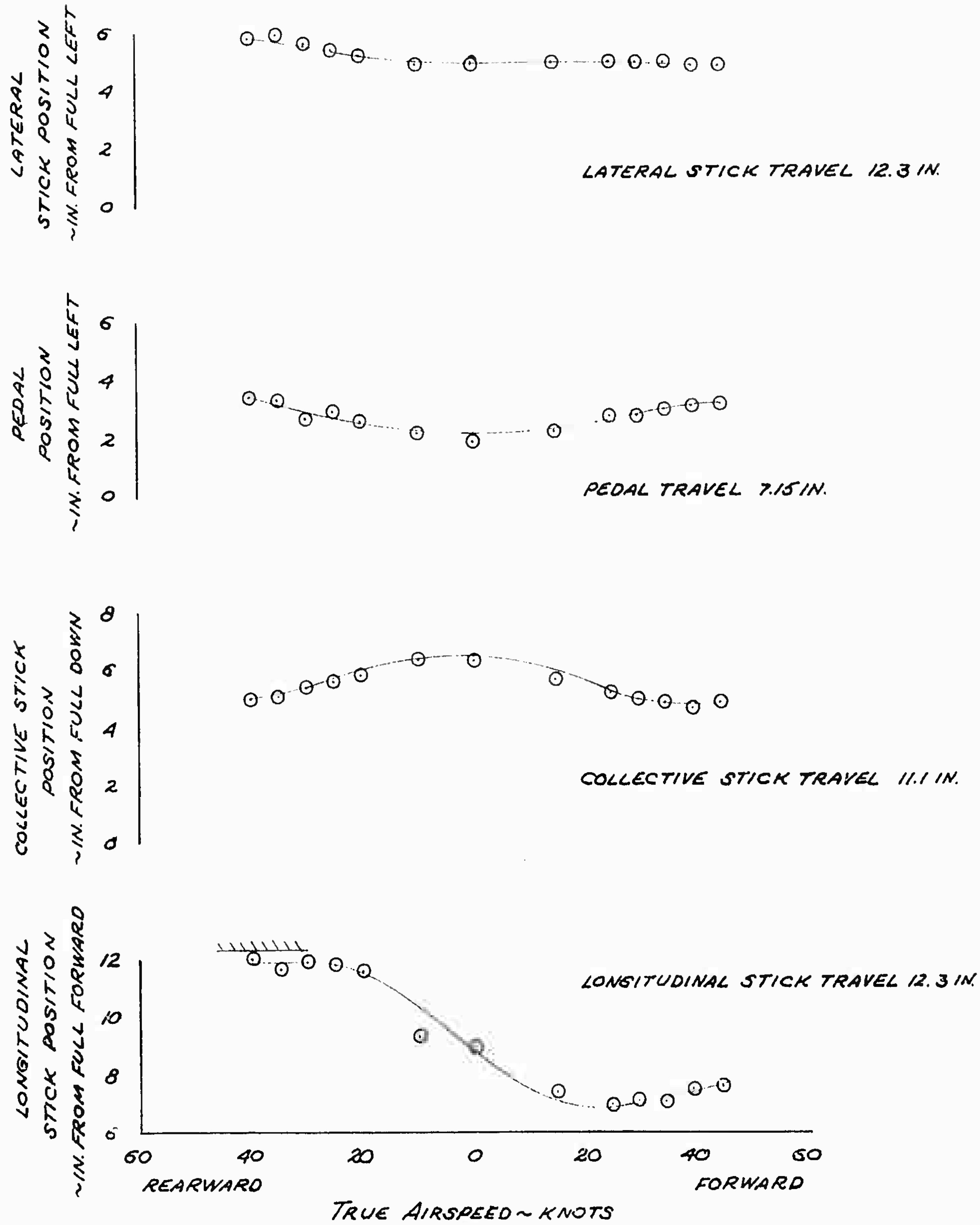


Figure No. 37
Control Positions in Forward and Rearward Flight
UH-1B USA S/N 60-3548
Float Kit Installed
DENSITY ALTITUDE = 2150 FT.   GROSS WEIGHT = 7610 LB
ROTOR SPEED = 324 RPM   CG LOCATION 126.3 (FWD)



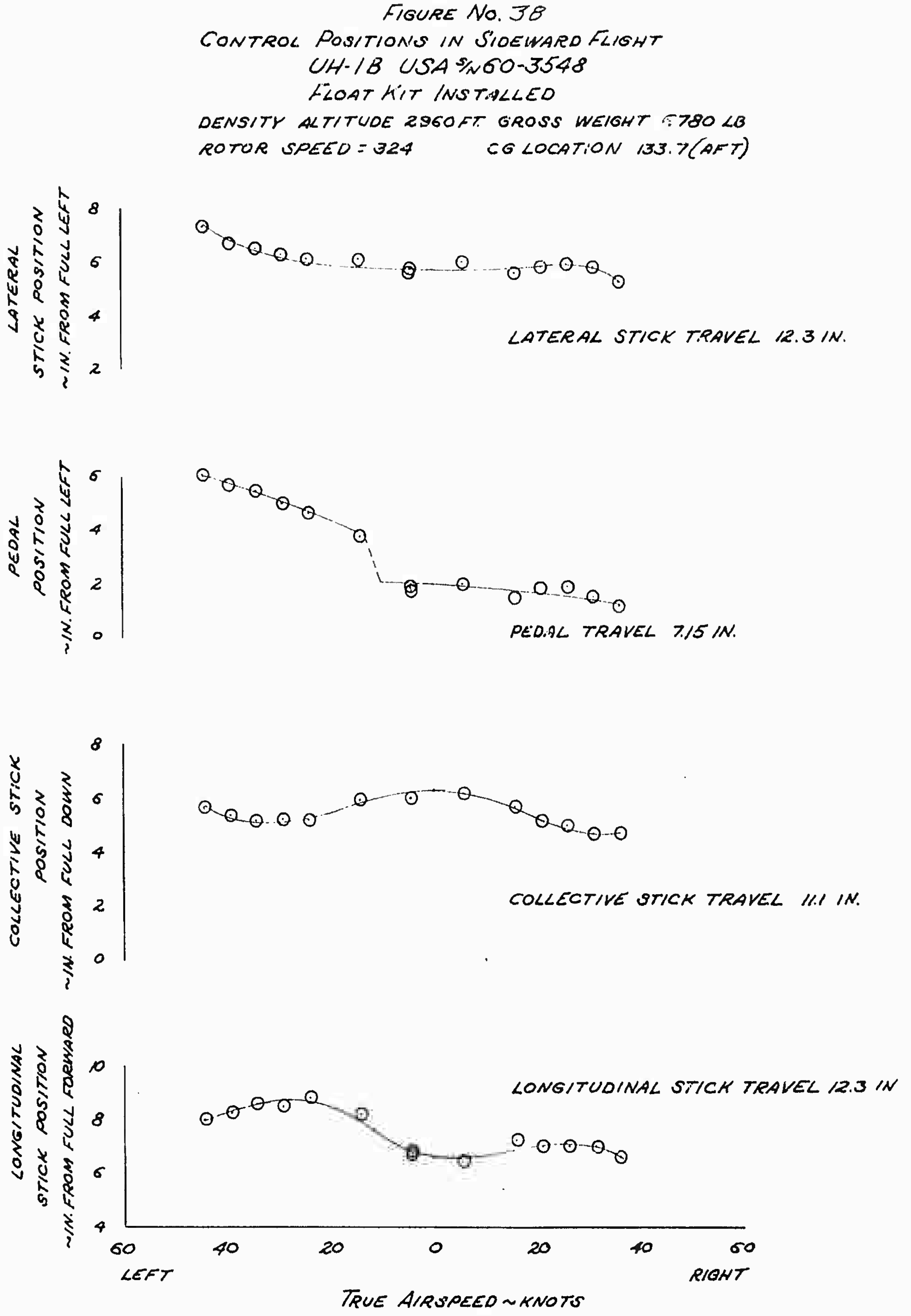
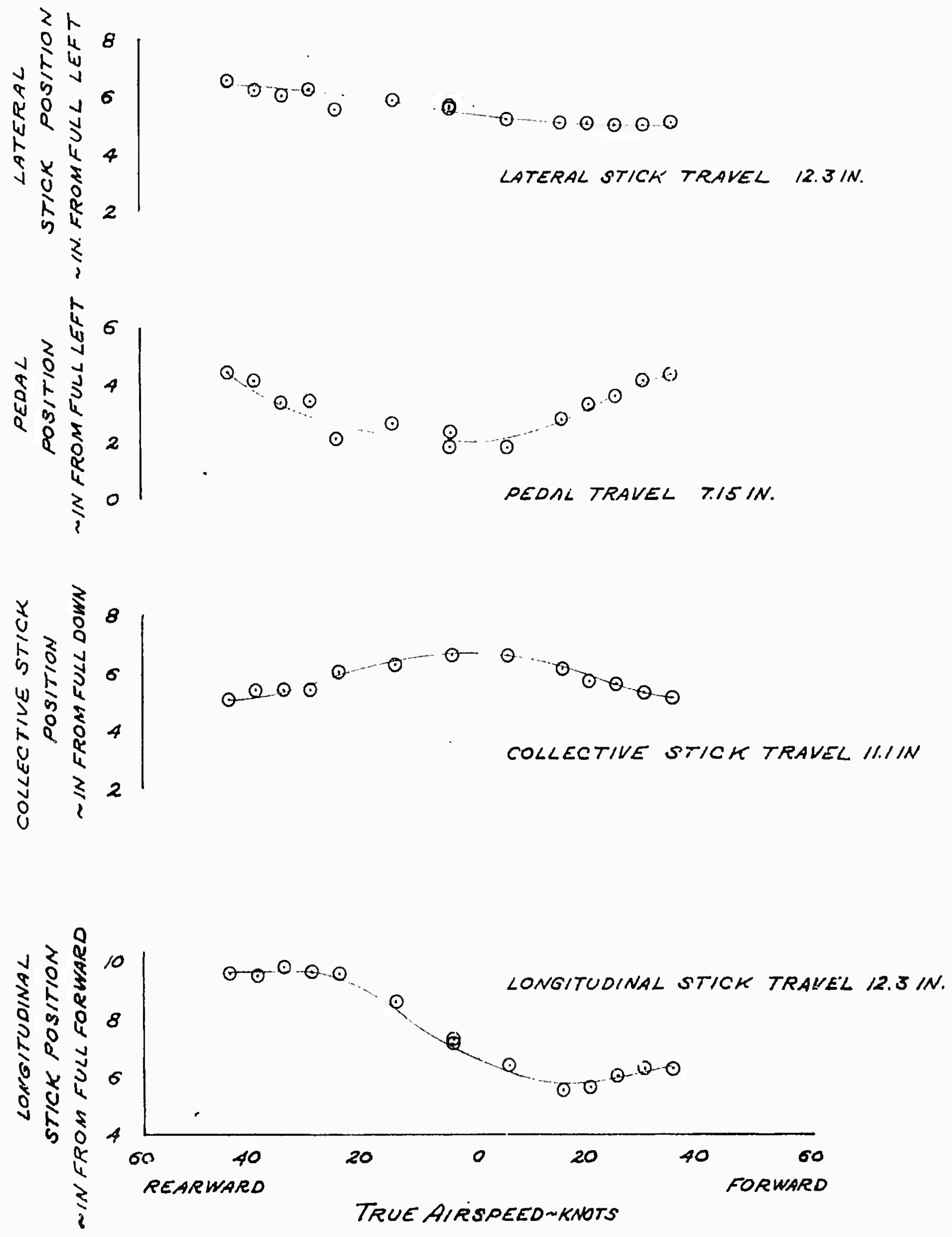


FIGURE NO. 38
CONTROL POSITIONS IN SIDEWARD FLIGHT
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED
DENSITY ALTITUDE 2960 FT. GROSS WEIGHT 6780 LB
ROTOR SPEED = 324 CG LOCATION 133.7 (AFT)
LATERAL STICK POSITION ~IN. FROM FULL LEFT
LATERAL STICK TRAVEL 12.3 IN.
PEDAL POSITION ~IN. FROM FULL LEFT
PEDAL TRAVEL 7.15 IN.
COLLECTIVE STICK POSITION ~IN. FROM FULL DOWN
COLLECTIVE STICK TRAVEL 11.1 IN.
LONGITUDINAL STICK POSITION ~IN. FROM FULL FORWARD
LONGITUDINAL STICK TRAVEL 12.3 IN
LEFT
RIGHT
TRUE AIRSPEED ~ KNOTS

FIGURE No. 39
CONTROL POSITIONS IN FORWARD AND REARWARD FLIGHT
UH-1B USA S/N 60-3548
FLOAT KIT INSTALLED

DENSITY ALTITUDE = 2150 FT. GROSS WEIGHT = 7620 LB.
ROTOR SPEED = 324 RPM CG LOCATION = 126.3 (FWD)



APPENDIX II

NOMENCLATURE AND DATA ANALYSIS METHODS

1.0 NOMENCLATURE

SYMBOL	DESCRIPTION	UNITS
A	Rotor Disc Area	ft^2
C.G.	Center of Gravity	in
C_P	Power Coefficient	--
C_T	Thrust Coefficient	--
dH_p/dt	Slope of Pressure Altitude versus Time Plot	fpm
H_D	Density Altitude	ft
H_P	Pressure Altitude	ft
KCAS	Knots Calibrated Airspeed	kt
KIAS	Indicated Airspeed	kt
K_P	Power Constant	--
KTAS	Knots True Airspeed	kt
K_W	Weight Constant	--
N_1	Gas Producer Speed	rpm
N_{II}	Power Turbine Output Speed	rpm
P	Pressure	lb/ft^2
P_{Ti}	Compressor Inlet Total Temperature	Kelvin
R/C	Rate of Climb	fpm
R	Rotor Radius	ft
SHP	Shaft Horsepower	$\frac{ft\text{-}lb}{min} \times \frac{1}{33{,}000}$

T	Temperature	°Kelvin
T_{Ti}	Compressor Inlet Total Temperature	°Kelvin
t	Time	min
V_C	Calibrated Airspeed	kt
V_T	True Airspeed	kt
W or GW	Gross Weight	lb
W_f	Fuel Flow	lb/hr
δ	$P \div 29.92$	--
θ	$T \div 288$	--
ρ	Density	$lb/sec^2/ft^4$
μ	Advance Ratio	--
Ω	Rotor Speed	rad/sec

2.0 DATA ANALYSIS METHODS

2.1 GENERAL

The equations and procedures used to correct the performance of this helicopter from test conditions to U. S. standard atmosphere conditions are described in this paragraph.

Dimensional analysis of the major items affecting helicopter performance will yield several sets of dimensionless variables which may be used to present performance data in non-dimensional form. The C_P, C_T, μ method is used in this report. These variables are defined as follows:

$$C_P = \frac{SHP \times 550}{\rho A\ (\Omega R)^3}$$

$$C_T = \frac{W}{\rho A\ (\Omega R)^2}$$

$$\mu = \frac{V_T}{\Omega R}$$

2.2 HOVERING

Hovering performance data was obtained using the free-flight hovering technique. Tests were flown at float heights of 5 feet and 15 feet. Gross weight and rotor rpm were varied to permit a large C_T range of values. For each test combination of gross weight, rotor rpm and float height, non-dimensional power and thrust coefficients were calculated. The data was presented with power coefficient plotted versus thrust coefficient at lines of constant float height.

2.3 CLIMBS

The observed rate of climb was corrected to tapeline rate of climb by the expression:

$$R/C_{test} = \frac{dH_p}{dt} \times \frac{T_{test}}{T_{standard}}$$

A power correction was then made to the tapeline rate of climb to obtain standard rate of climb. Power available during the test was corrected to standard-day conditions by the following equation:

$$\Delta R/C_{power} = K_p \times \frac{\Delta SHP \times 33{,}000}{GW_{test}}$$

where:

ΔSHP = SHP available from reference e minus SHP observed during test.

GW_{test} = Test gross weight at altitude at which SHP was obtained.

K_p = Power constant determined by flight test = 0.578.

Gross weight corrections were made by use of the following equation:

$$\Delta R/C_{weight} = K_W \times SHP_s \times 33{,}000 \left(\frac{1}{GW_{std}} - \frac{1}{GW_{test}}\right)$$

where:

SHP_s = Standard shaft horsepower at a given altitude.

GW_{test} = Test gross weight.

GW_{std} = Standard gross weight.

K_W = Weight constant obtained from reference h = .745.

2.4 LEVEL FLIGHT

Each level flight speed power was flown at an approximately constant C_T. This involves increasing altitude as fuel is burned. The data was corrected for SHP to a constant C_T as follows:

$$SHP_{std} = SHP_{test} \times \frac{\rho_{std}}{\rho_{test}}$$

The non-dimensional parameters C_P, C_T, and μ were used for correlation of the level flight data.

For each flight, airspeed and power required were reduced to non-dimensional form and a plot was made of C_P versus μ at the average C_T flown. A curve was faired through the points and faired line values were used to construct a carpet plot of C_P versus C_T. On this plot, lines of constant μ were then faired through the various test curves, thus defining power required for any altitude, gross weight, airspeed and rotor rpm.

2.5 AUTOROTATIONAL DESCENTS

The observed rate of descent during stabilized autorotations was corrected to a tapeline rate of descent by the following expression:

$$\text{Rate of Descent}_{tapeline} = \frac{dH_p}{dt} \left(\frac{T_{test}}{T_{std}}\right)$$

APPENDIX III

TEST INSTRUMENTATION

Test instrumentation was installed and maintained by personnel of the Logistics Division, USAAVNTA, Edwards Air Force Base, California. Specialized sensitive, calibrated instruments were installed in the test aircraft. A test airspeed system was installed on a boom mounted on the nose of the aircraft. The following parameters were recorded:

a. Pilot-Engineer's Panel

(1) Boom System Airspeed

(2) Boom System Altitude

(3) Ship System Airspeed

(4) Ship System Altitude

(5) Free Air Temperature

(6) Engine Differential Torque

(7) Rotor Speed

(8) Gas Producer Speed

(9) Exhaust Gas Temperature

(10) Angle of Sideslip

(11) Longitudinal Cyclic Control Position

(12) Fuel Flow Stepper Motor

(13) Fuel Totalizer

(14) Photo Panel Intervalometer

(15) Photo Panel Counter

(16) Oscillograph Counter

b. Photo Panel

(1) Boom System Airspeed

(2) Boom System Altitude

(3) Free Air Temperature

(4) Rotor Speed

(5) Gas Producer Speed

(6) Exhaust Gas Temperature

(7) Time of Day

(8) Fuel Totalizer

(9) Photo Panel Counter

(10) Oscillograph Counter

c. 50-Channel Oscillograph

(1) Pitch Angle

(2) Roll Angle

(3) Yaw Angle

(4) Pitch Rate

(5) Roll Rate

(6) Yaw Rate

(7) Pitch Angular Acceleration

(8) Roll Angular Acceleration

(9) Longitudinal Cyclic Position

(10) Lateral Cyclic Position

(11) Pedal Position

(12) Collective Position

(13) Throttle Position

(14) Angle of Sideslip

(15) C.G. Normal Acceleration

(16) Rotor RPM

APPENDIX IV

GENERAL AIRCRAFT INFORMATION

1.0 AIRCRAFT DESCRIPTION

The aircraft on which the floatation landing gear was mounted was a standard UH-1B, S/N 60-3548. The aircraft was powered by a T53-L-9A engine, S/N LEO-6309.

The UH-1B is a single main rotor helicopter incorporating a conventional antitorque tail rotor. The main rotor is a two-bladed, semi-rigid, see-saw type employing preconing and under-slinging. Conventional cyclic and directional controls are provided. A stabilizer bar is used to provide stability. A detailed description of the helicopter is provided in reference j.

2.0 AIRCRAFT DIMENSIONS

The following abbreviated list of dimensions is provided to enable the reader to calculate specific performance problems from generalized data presented in this report. A complete description of the aircraft is provided in reference j.

a. Main Rotor

Number of blades	2
Rotor diameter	44 ft
Rotor solidity	0.0506
Blade chord (root to tip)	21 in
Swept area	1520 ft^2

b. Tail Rotor

Number of blades	2
Swept area	56.5 ft^2

c. Gear Ratios

Power turbine to engine output shaft	3.22 to 1
Engine output shaft to main rotor	20.37 to 1
Engine output shaft to tail rotor	3.97 to 1

3.0 WEIGHT AND BALANCE

The test aircraft was weighed in an instrumented condition first with the standard skid gear installed and second with the floatation landing gear installed. The difference between these weighings was the net increase in weight that would result when operating the UH-1B with floatation gear installed, in this case 376 pounds.

A typical mission loading would be as follows:

UH-1B Operating weight (reference i)	4787 lb
Fuel 155 gallons	1008
Crew of 2	400
Weight increment due to floatation gear	376
Payload	1429
Engine Start Gross Weight	8000 lb

APPENDIX V

REFERENCES

a. Report No. 204-099-174, "Preliminary Flight Test Results Model 204B Float Certification," Bell Helicopter Company, November 1963.

b. Unclassified Message 6-1168, AMCPM-IR-T, Hq, U. S. Army Materiel Command (USAMC), 20 June 1964, subject: "Engineering/Service Test of UH-1B and UH-1D Water Floatation Gear."

c. Plan of Test for "Engineering Test of UH-1B Helicopter Equipped with Bell Helicopter Floatation Gear," U. S. Army Aviation Test Activity, January 1965.

d. Letter, AMSTE-BG, Hq, U. S. Army Test and Evaluation Command, 19 February 1965, subject: "Plan of Test for the Engineering Test of UH-1B Helicopter Equipped with Bell Helicopter Floatation Gear, USATECOM Project No. 4-5-5301-01."

e. Report No. 204-099-712, "Substantiating Data for the Standard Aircraft Characteristics Charts for the UH-1B Helicopter," Bell Helicopter Company, 5 May 1963.

f. Technical Manual TM55-1520-211-10, "Operator's Manual Army Models UH-1A and UH-1B Helicopters," Department of the Army, 1964.

g. Military Specification MIL-H-8501A, "General Requirement for Helicopter Flying and Ground Handling Qualities," 7 September 1961.

h. Report FTC-TDR-62-21, "YHU-1B Category II Performance Tests," U. S. AFFTC, December 1962 (AD296012).

i. Report FTC-TDR-62-13, "YHU-1B Stability and Control Tests," U. S. AFFTC, August 1962.

j. Report No. 204-947-125, "Detail Specification for UH-1B Utility Helicopter," Bell Helicopter Company, May 1963.

k. Report No. 204-099-180, "Evaluation of 204-706-053 Float Kit in the Model UH-1B and Model UH-1D Helicopters," Bell Helicopter Company, 20 March 1964.

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11 SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Iroquois Project Manager U. S. Army Materiel Command

13 ABSTRACT

A limited engineering flight test evaluation of the UH-1B equipped with floatation landing gear was conducted by the U. S. Army Aviation Test Activity (USAAVNTA). The objectives of the program were to verify and amplify the data obtained during the manufacturer's flight testing and establish the basis for the Operator's Manual data to be used for UH-1B helicopters equipped with floatation landing gear. The USAAVNTA was designated Executive Test Agency and was responsible for test plan preparation, test execution, and test reporting. A total of 40 flights for 27 productive flight hours was flown at Edwards Air Force Base and Bakersfield, California, from 27 July 1965 through 10 September 1965. The UH-1B equipped with floatation landing gear could be flown with reasonable safety within a restricted flight envelope compared with a standard UH-1B. The overall flying qualities were inferior to those of a standard UH-1B. Installation of the floatation landing gear resulted in a significant performance penalty. The water handling characteristics were considered excellent. Several warning statements and notations describing peculiarities in handling qualities were recommended for insertion in the Operator's Manual for operating UH-1B's with floatation landing gear. A restricted flight envelope was recommended for the UH-1B equipped with floatation landing gear. The performance test results were recommended for incorporation in the Operator's Manual.

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Engineering Test						
UH-1B Helicopter						
Floatation Landing Gear						
Flying Qualities						
Water Handling Characteristics						
Handling Qualities						
Performance Test						
Stability and Control Test						
Operator's Manual Data						

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